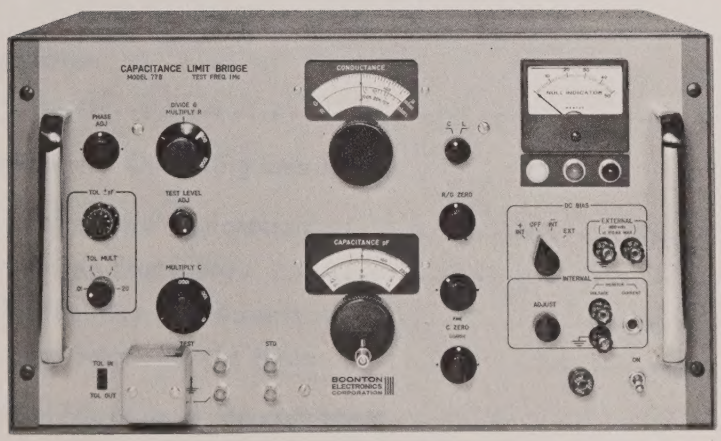
OPERATOR'S MANUAL
for
CAPACITANCE LIMIT BRIDGE
MODEL 77B (1 MHz)
and
MODEL 77B-S1 (100 kHz)



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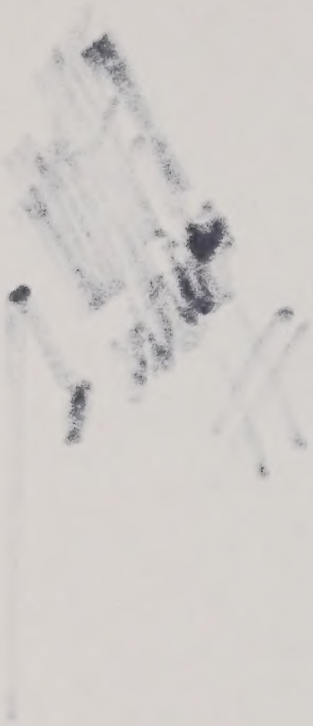

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CHAPTER 1

DESCRIPTION AND DATA

1-1 INTRODUCTION

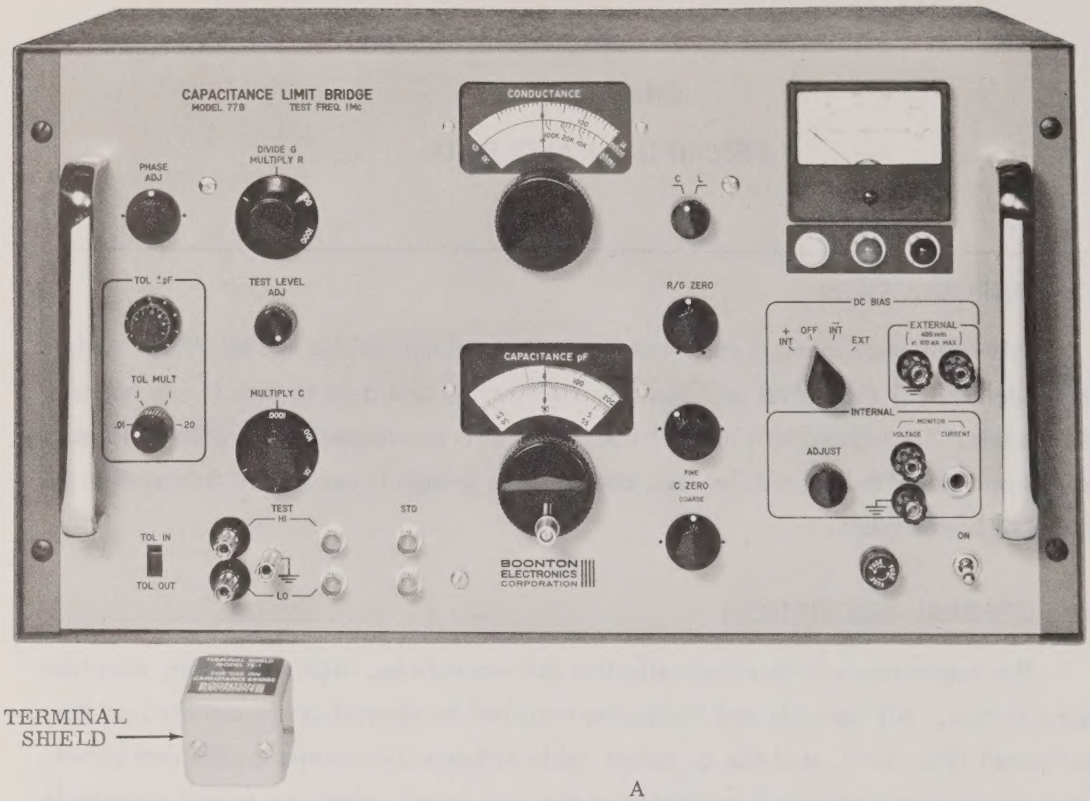
This instruction manual describes Capacitance Limit Bridge Model 77B (1 MHz) and Model 77B-S1 (100 kHz) and contains information and data to install and operate both models. Throughout this manual the two models are respectively referred to as the 77B and the 77B-S1, and the term capacitance bridge is used when information applies to both models.

1-2 GENERAL DESCRIPTION

The capacitance bridge basically is a self-contained, high resolution, modified Young bridge. All controls and indicators required for operation are mounted on the front panel (Fig. 1-1), and the ac power cable is bracket-mounted on the rear panel. A test-decision output also is available at the rear panel, where an output receptacle and mating connector provide facilities for connecting the capacitance bridge in an automated testing and sorting system. The capacitance bridge contains a null detector, power supply, bias supply, and crystal-controlled oscillator, and each model may be operated without any external equipment. Both models are functionally identical, differing only in test frequency, measurement range, and accuracy characteristics, as specified in Paragraphs 1-4 and 1-5. If required, the capacitance bridge may be removed from its cabinet and installed in a standard 19-inch rack.

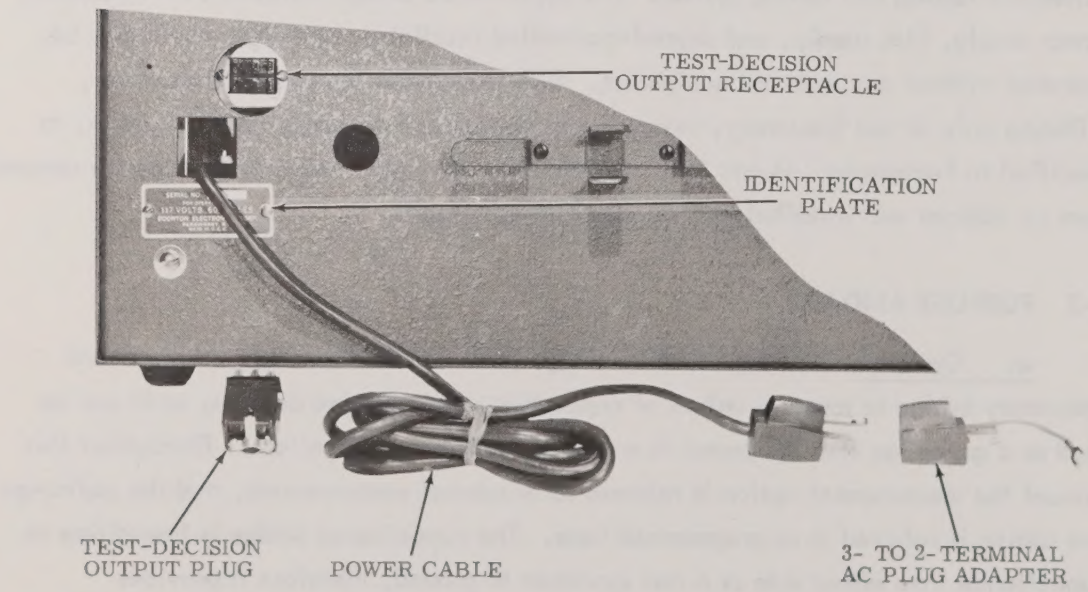
1-3 PURPOSE AND USE

a. General. The capacitance bridge can be used either as a conventional laboratory bridge to measure values of capacitive and inductive devices, or it can be used as a go/no-go test equipment in component-sorting applications. Throughout this manual the measurement option is referred to as manual measurements, and the go/no-go test option is referred to as programmed tests. The capacitance bridge is insensitive to capacitance from either side of a test specimen to ground, therefore it provides accurate readings even in the presence of relatively large stray capacitance. Thus, the direct capacitance of either 3-terminal or 2-terminal capacitors is precisely measured, and remote test jigs or coaxial cables may be used to connect test specimens



A

FRONT PANEL



B

REAR PANEL

Figure 1-1. Capacitance Limit Bridge Model 77B

without introducing errors due to jig or cable capacitance. Test specimens can be biased directly by the internal dc supply, or an external bias voltage may be applied through front-panel terminals. External capacitance standards also may be connected at the front panel to check calibration and to perform comparison or differential measurements.

b. Manual measurements. The manual-measurement mode of operation is used to precisely measure capacitance or inductance of capacitors, inductors, and semiconductors. The capacitance bridge provides direct readings for values of parallel capacitance (C), equivalent parallel resistance (R_p), and conductance (G), while parallel inductance (L) values and Q are readily determined by simple computation.

c. Programmed Tests. The programmed-test mode of operation is used in component-sorting applications to perform either dual-limit or single-limit tests of capacitors, inductors, or semiconductors on a go/no-go basis. The capacitance bridge provides semiautomatic operation when test specimens are hand fed, usually by means of a remote test jig. The capacitance bridge also may be incorporated in an automated testing and sorting system to provide fully automatic testing and sorting functions.

1-4 TECHNICAL CHARACTERISTICS OF MODEL 77B

a. Capacitance Measurements.

Capacitance Range:

Programmed tests	0.001 pF to 1000 pF
Manual measurements	0 to 1000 pF

Capacitance Limits:

Tolerance range	±0.0005 pF to ±200 pF
Tolerance setting accuracy	±1% of setting or ±0.0001 pF, whichever is greater

Capacitance Accuracy and Resolution:

C Multiplier	Capacitance Range	Resolution	Accuracy	
			Manual Measurements	Programmed Tests * (C nominal)
1.0	0 to 1000 pF	0.2 pF	$\pm\left[0.25\% + \left(\frac{1000}{R_p} + 0.5\right)\text{pF}\right]$	$\pm\left[(0.25 + \frac{3}{Q}^{**})\% + 0.5 \text{ pF}\right]$
0.1	0 to 100 pF	0.02 pF	$\pm\left[0.25\% + \left(\frac{1000}{R_p} + 0.02\right)\text{pF}\right]$	$\pm\left[(0.25 + \frac{3}{Q})\% + 0.05 \text{ pF}\right]$
0.01	0 to 10 pF	0.002 pF	$\pm\left[0.25\% + \left(\frac{1000}{R_p} + 0.005\right)\text{pF}\right]$	$\pm\left[(0.25 + \frac{3}{Q})\% + 0.005 \text{ pF}\right]$
0.001	0 to 1 pF	0.0002 pF	$\pm\left[0.25\% + \left(\frac{1000}{R_p} + 0.001\right)\text{pF}\right]$	$\pm\left[(0.25 + \frac{3}{Q})\% + 0.001 \text{ pF}\right]$
0.0001	0 to 0.1 pF	0.0001 pF	$\pm\left[2\% + \left(\frac{1000}{R_p} + 0.00005\right)\text{pF}\right]$	———

Where R_p is equivalent parallel resistance of specimen in ohms

* Programmed for zero tolerance.
** TOL MULT switch in position 20.

b. Inductance Measurements.

Inductance Range..... 25 μH to 25 mH

Inductance Limits:

Tolerance range ..... 0 to ±20% of nominal inductance

Tolerance setting accuracy..... Approximately 1% of limit value

Inductance Accuracy:

C Multiplier	Inductance Range	Accuracy	
		Manual Measurements	Programmed Tests* (L nominal)
1	25 μH to 250 μH	$\pm(0.25 + 2L + \frac{4000L}{R_p})\%$	$\pm(0.25 + \frac{3}{Q} + 2L)\%$ **
0.1	250 μH to 2.5 mH	$\pm(0.25 + \frac{L}{10} + \frac{4000L}{R_p})\%$	$\pm(0.25 + \frac{3}{Q} + \frac{L}{5})\%$
0.01	2.5 mH to 25 mH	$\pm(0.25 + \frac{L}{50} + \frac{4000L}{R_p})\%$	$\pm(0.25 + \frac{3}{Q} + \frac{L}{50})\%$

Where

L is inductance of specimen in millihenries

R_p is equivalent parallel resistance of specimen in ohms

* Programmed for zero tolerance

** TOL MULT switch in position 20.

c. Conductance Measurements.

Conductance Range

(Manual measurements only).....0 to 1000 μmhos

Conductance Accuracy and Resolution:

G Divider	Conductance Range	Accuracy	Resolution
1	0 to 1000 μmhos	$\pm\left[(10+\frac{Q}{500})\% + 10 \text{ μmhos}\right]$	10 μmhos
10	0 to 100 μmhos	$\pm\left[(5+\frac{Q}{500})\% + 1 \text{ μmho}\right]$	1 μmho
100	0 to 10 μmhos	$\pm\left[(5+\frac{Q}{500})\% + 0.1 \text{ μmho}\right]$	0.1 μmho
1000	0 to 1 μmho	$\pm\left[(5+\frac{Q}{500})\% + 0.01 \text{ μmho}\right]$	0.01 μmho

d. Resistance Measurements.

Resistance Range

(Manual measurements only).....1000 Ω to 100 MΩ

Resistance Accuracy and Resolution:

R Multiplier	Resistance Range	Accuracy	Resolution
1	1 K to 100 KΩ	$\pm(10 + \frac{Q}{500} + \frac{R_p}{10^3})\%$	$\frac{R_p}{10^3}\%$
10	10 K to 1 MΩ	$\pm(5 + \frac{Q}{500} + \frac{R_p}{10^4})\%$	$\frac{R_p}{10^4}\%$
100	100 K to 10 MΩ	$\pm(5 + \frac{Q}{500} + \frac{R_p}{10^5})\%$	$\frac{R_p}{10^5}\%$
1000	1 MΩ to 100 MΩ	$\pm(5 + \frac{Q}{500} + \frac{R_p}{10^6})\%$	$\frac{R_p}{10^6}\%$

Where R_p is equivalent parallel resistance of specimen in ohms

e. Test Oscillator.

Type.....Crystal controlled

Frequency.....1 MHz ±200 Hz

Level.....1 mV to 250 mV

f. DC Bias.

Internal.....-6V to +150V

External.....Up to ±400V at 100 mA

g. Test-Decision Outputs.

Visual:

Capacitance measurements..... Glowing green, red, or yellow panel lamp respectively indicates go, high, or low capacitance.

Inductance measurements..... Glowing green, red, or yellow panel lamp respectively indicates go, low, or high inductance.

Electrical..... 6.3 V line-frequency sample of indicator lamp filament voltage at test-decision output receptacle (Fig. 2-2).

Continuity..... Relay contact closures consistent with test results at test-decision output receptacle.

h. Automatic Test Time..... 0.05 sec. (approx.)

i. Power Requirements..... As specified on capacitance bridge:

105 to 125 V, 60 Hz
105 to 125 V, 50 Hz
210 to 250 V, 60 Hz
210 to 250 V, 50 Hz

j. Power Consumption..... 55 W

k. Physical Characteristics.

Dimensions:

Installed in cabinet..... 11-1/4" h X 19-1/2" w X 12-3/4" d
Without cabinet..... 10-1/2" h X 19" w X 10-1/8" d

Weight:

Installed in cabinet..... 35 lbs.
Without cabinet..... 25 lbs.

1-5 TECHNICAL CHARACTERISTICS OF MODEL 77B-S1

The technical characteristics of Model 77B-S1 are identical to those of Model 77B except as indicated below.

a. Capacitance Measurements.

Capacitance Range.....0.001 pF to 1000 pF

Capacitance Accuracy and Resolution:

C Multiplier	Capacitance Range	Resolution	Accuracy	
			Manual Measurements	Programmed Tests* (C nominal)
1.0	0 to 1000 pF	0.2 pF	$\pm\left[0.1\% + \left(\frac{1000}{R_p} + 0.2\right) \text{pF}\right]$	$\pm\left(0.1 + \frac{3}{Q}\right)\% + 0.2 \text{ pF}$ **
0.1	0 to 100 pF	0.02 pF	$\pm\left[0.1\% + \left(\frac{1000}{R_p} + 0.05\right) \text{pF}\right]$	$\pm\left(0.1 + \frac{3}{Q}\right)\% + 0.05 \text{ pF}$
0.01	0 to 10 pF	0.002 pF	$\pm\left[0.1\% + \left(\frac{1000}{R_p} + 0.01\right) \text{pF}\right]$	$\pm\left(0.1 + \frac{3}{Q}\right)\% + 0.01 \text{ pF}$
0.001	0.05 to 1 pF	0.0002 pF	$\pm\left[0.1\% + \left(\frac{1000}{R_p} + 0.002\right) \text{pF}\right]$	$\pm\left(0.1 + \frac{3}{Q}\right)\% + 0.002 \text{ pF}$
0.001	0 to 0.05 pF	0.0002 pF	$\pm\left[2\% + \left(\frac{1000}{R_p} + 0.0002\right) \text{pF}\right]$	$\pm\left(2 + \frac{2}{Q}\right)\% + 0.0002 \text{ pF}$

Where R_p is equivalent parallel resistance of specimen in ohms

* Programmed for zero tolerance
** TOL MULT switch in position 20.

b. Inductance Measurements.

Inductance Range.....2.5 mH to 250 mH

Inductance Accuracy:

C Multiplier	Inductance Range	Accuracy	
		Manual Measurements	Programmed Tests* (L nominal)
1.0	2.5 mH to 25 mH	$\pm(0.1 + \frac{L}{10K} + \frac{40L}{R_p})\%$	$\pm(0.1 + \frac{3}{Q} + \frac{L}{100})\%$ **
0.1	25 mH to 250 mH	$\pm(0.1 + \frac{L}{50K} + \frac{40L}{R_p})\%$	$\pm(0.1 + \frac{3}{Q} + \frac{L}{500})\%$

Where

L is inductance of specimen in millihenries

R_p is equivalent parallel resistance of specimen in ohms

* Programmed for zero tolerance
** TOL MULT switch in position 20.

c. Test Oscillator.

Frequency.....100 kHz ±20 Hz

1-6 ACCESSORIES AND ASSOCIATED EQUIPMENT

a. Accessories Supplied.

Table 1-1 lists the accessories supplied with each capacitance bridge.

Table 1-1. Accessories Supplied with Capacitance Bridge.

Accessory	Function
Terminal Shield, Model TS-1 (Fig. 1-1)	Shields front panel TEST binding posts from hand capacitance or similar stray-capacitance effects when tests are made at the BNC TEST connectors.
3- to 2-terminal ac plug adapter (Fig. 1-1)	Connects 3-terminal ac power plug to 2-terminal ac receptacle.
Test decision output plug (Fig. 1-1)	Used to connect an external cable to the test-decision output receptacle.
Operator's Manual for Capacitance Limit Bridge Model 77B and Model 77B-S1	Instruction manual.

b. Optional Accessories.

The accessories described in Table 1-2 are available for use with the capacitance bridge to increase its versatility. For additional information, contact either your nearest sales engineering representative, listed at the rear of the instruction manual, or the Boonton Electronics Corporation.

Table 1-2. Optional Accessories for Models 77B and 77B-S1

Accessory	Function
Capacitance Standards Model CS-	Transfer standards calibrated against NBS-certified reference standards. Used to calibrate or check the accuracy of 3-terminal capacitance bridges and to provide high resolution comparison measurements. Available in any value from 0.01- to 1000-pF at 0.1% accuracy. Designed for operation from 1 kHz to 1 MHz.
Remote Test Jig, Model 77-1A	Convenience test fixture supplied with coaxial cables. Used to electrically extend the front panel TEST terminals to magnetic or spring-loaded terminals on the test jig. Yellow, green, and red indicator lamps on the jig duplicate the test decision lamps on the front panel of the capacitance bridge.
Range Extender, Model 77-2A	Used with Model 77B for manual measurements only. Extends the capacitance range to 0.1 μF, the conductance range to 1 mho, the resistance range to 1 ohm, and the inductance range to 0.25 μH.
Range Extender, Model 77-3A	Used with Model 77B-S1 for manual measurements only. Extends the capacitance range to 1 μF, the conductance range to 1 mho, the resistance range to 1 ohm, and the inductance range to 2.5 μH.

Table 1-2. Optional Accessories (Cont.)

Accessory	Function
Range Divider, Model 77-4A	Used with 77B for manual measurements only. Divides capacitance readings by a fixed factor of 10 and permits measurements down to 0.00001 pF.
Range Divider, Model 77-5A	Used with 77B-S1 for manual measurements only. Divides capacitance readings by a fixed factor of 10 and permits measurements down to 0.0001 pF.
Dust Covers	Perforated metallic covers. Replace cabinet when the capacitance bridge is rack-mounted.

c. Associated Equipment.

The equipment described in Table 1-3 is available for use with the capacitance bridge in an automated testing and sorting system. For additional information, contact either your nearest sales engineering representative, listed at the rear of this instruction manual, or the Boonton Electronics Corporation.

Table 1-3. Associated Equipment

Accuracy	Function
Component Feeder, Model 850B (Fig. 3-4)	Feeder and sorter for axial-lead components. Automatically sorts either bulk or packaged components into high, low, or go bins.
Control Unit, Model 52-8A (Fig. 3-4)	Interface control unit in an automated testing and sorting system. In typical application, receives test decision data from the capacitance bridge and controls the sorting operations of the Model 850B Component Feeder. All high, low, and go sorting operations are counted and displayed by the control unit.

CHAPTER 2

INSTALLATION

2-1 UNPACKING AND INSPECTION

a. Remove the packing material from the shipping carton in accordance with Figure 2-1 and carefully remove the capacitance bridge. If feasible, the carton and packing material may be stored for possible future reshipment. Remove the protective plastic sleeves from the two front-panel handles. Check that the accessories listed in Table 1-1 were packed with the instrument.

NOTE

The test-decision output plug normally is installed in the rear panel mating receptacle; however, in some shipments it may be taped to a handle on the front panel.

b. Carefully inspect the capacitance bridge for any damage that may have been caused during shipment. Also check the performance of the capacitance bridge in accordance with the equipment performance checklist procedure in Chapter 4.

2-2 PACKAGING FOR RESHIPMENT

If required, pack the capacitance bridge for reshipment to the manufacturer in accordance with Figure 2-1 and the shipping instructions on the warranty. Observe the following special packing instructions:

a. If possible, use the original shipping carton and packing material.

b. Secure the ac power cable around the rear-panel cable bracket.

c. Return all accessories.

d. Tie a tag or envelope to the front panel handle and include the following information:

   1. Name and address of purchaser.

   2. Model number and serial number of equipment.

   3. Full description of damage or defect.

UNPACKING: UNPACK IN ACCORDANCE WITH THE EXPLODED-VIEW DIAGRAM SEQUENCE.

REPACKING: IF POSSIBLE, USE THE ORIGINAL PACKING MATERIAL. REFER TO THE DIAGRAM AND PERFORM THE FOLLOWING PROCEDURE:

1. Place the BOTTOM CUSHION in the CARTON.
2. Form the SHELL and insert it in the CARTON.
3. Check that the terminal shield is installed on the instrument's front-panel TEST binding posts and the ac power cable is secured to the rear-panel bracket.
4. Slide the instrument into the SHELL so that the front panel faces upward.
5. Insert the END SPACER between one end of the instrument and the SHELL.
6. Wedge the four CORNER PADS between the SHELL and CARTON corners.
7. Seat the PANEL GUARD on top of the instrument so that it extends around the front-panel handles.
8. Place the TOP CUSHION on top of the PANEL GUARD.
9. Fold the CARTON flaps and seal with gummed tape.

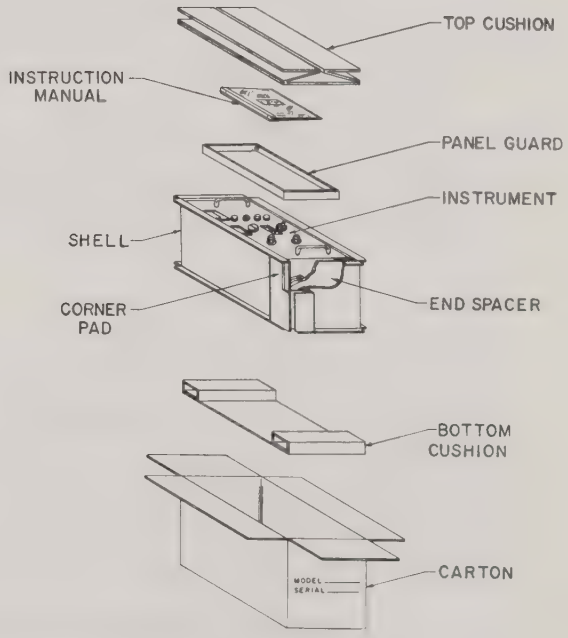


Figure 2-1. Capacitance Bridge Packaging.

2-3 POWER CONNECTIONS

Check that the ac power source is compatible with the voltage and frequency requirements specified on the rear-panel identification plate, and connect the power-cable plug to an appropriate receptacle. If a 3-terminal ac receptacle is available, remove the 3- to 2-terminal ac plug adapter from the power cable before making the power connection. If a 2-terminal ac receptacle is used, connect the plug-adapter pigtail to ground when the adapter is connected to the receptacle. Either procedure puts both the instrument panel and the cabinet at ground potential and protects operating personnel from any electrical shock hazards.

2-4 RACK INSTALLATION

If the capacitance bridge is to be installed in a rack, proceed as follows:

a. Remove the four screws at the sides of the front panel and remove the two edge strips.

b. Grasp the two front-panel handles and carefully slide the unit out of the cabinet.

c. Feed the power cable through the cutout on the rear panel and remove the cabinet.

d. Installation of dust covers (Part Nos. 600228 and 600229) is recommended. Proceed as follows:

   1. Feed the power cable through the cutout in the lower dust cover.

   2. Secure the lower dust cover to the bottom of the chassis with six No. 6 self-tapping screws 1/4" long.

   3. Use eight No. 6 self-tapping screws 1/4" long to secure the upper dust cover.

   4. Remove the two attaching screws from the name plate on the rear of the cabinet and secure the name plate to the rear of the upper dust cover.

e. Install the capacitance bridge in the rack, as required, and secure with panel screws.

f. Connect the power cable to an appropriate ac power receptacle (Para. 2-3).

2-5 WIRING TEST-DECISION OUTPUT PLUG

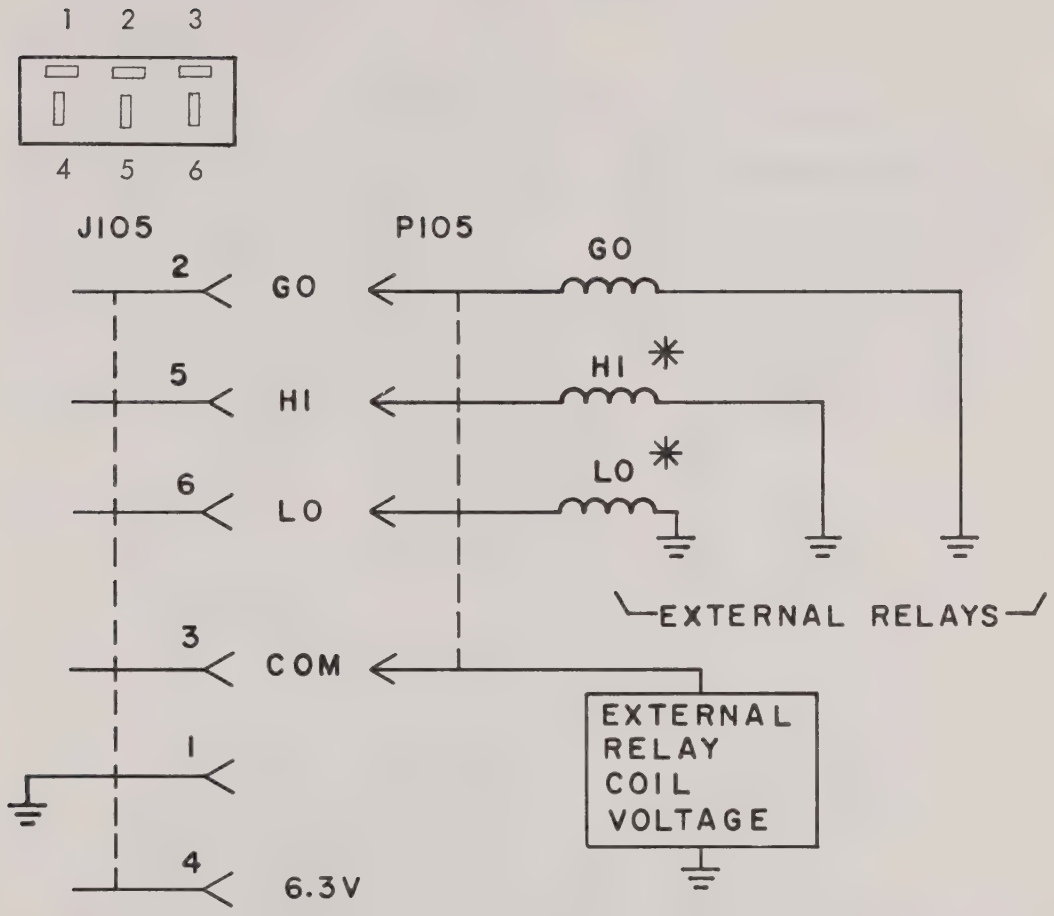
If the capacitance bridge is to be used in an automated testing and sorting system, wire the test-decision output plug (Fig. 1-1) as follows:

a. Remove the test-decision output plug from its mating receptacle at the rear of the capacitance bridge.

b. Check that the interfacing unit's connecting element is a 4- or 6-conductor cable and tag each lead.

c. Refer to Figure 2-2 for wiring information, and wire the cable leads to the test-decision output plug terminals as follows:

1. Refer to Figure 2-3. Loosen the two cable-clamp screws on the plug.
2. Remove the outer nut on the plug casing to release one of the casing side panels.
3. Grasp the terminal block and pull up on the released side panel until the plug casing swivels upward about 90 degrees.
4. Remove the plug casing from the secured side panel by disengaging the casing from the pivot lug.
5. Prepare the 6-conductor cable for soldering, and feed the end of the cable through the cable clamp.
6. Solder the cable leads to the required terminal lugs.
7. Insert the pivot lug into the plug casing slot and push the casing down to its closed position.
8. Secure the plug's side panel with the outer nut.
9. Check cable-lead dress and tighten the cable clamp.
10. Connect the plug to the test-decision output receptacle (J105 on schematic diagram).

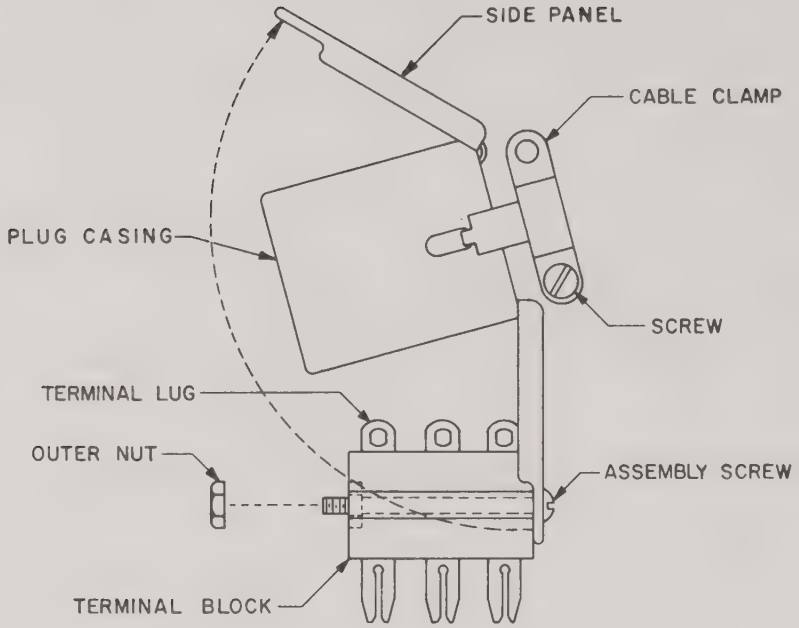


* DURING INDUCTANCE MEASUREMENTS, A HI INDICATION IS DERIVED FROM PIN 6 AND A LO INDICATION IS DERIVED FROM PIN 5.

Figure 2-2. Test-Decision Output Plug P105 Wiring Diagram.

A

SIDE VIEW



B

TOP VIEW

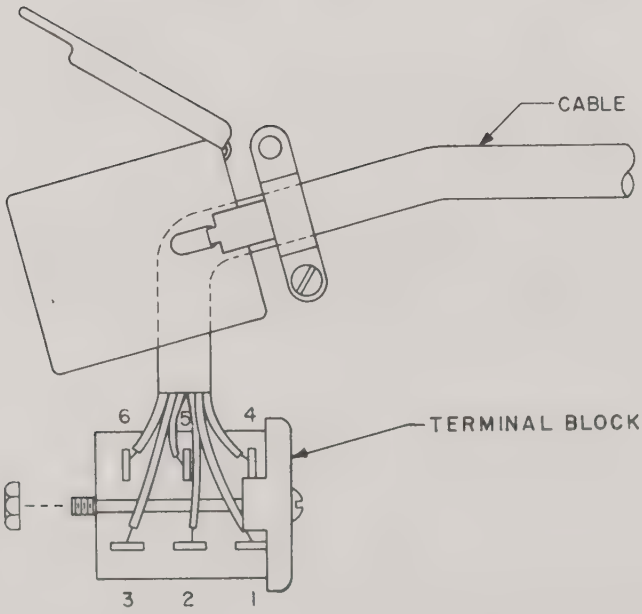


Figure 2-3. Test-Decision Output Plug Disassembly.

CHAPTER 3

OPERATION

3-1 GENERAL

This chapter contains procedures to perform manual measurements and programmed tests with the capacitance bridge. Refer to Sections II and III for 77B procedures and to Sections IV and V for 77B-S1 procedures. Before performing any measurements or tests, however, observe the preliminary operating instructions in Section I and thoroughly review the function of each control and indicator in Table 3-1. When performing either manual measurements or programmed tests, refer to the applicable accuracy formulas in Paragraph 1-4 or 1-5, and especially note that the accuracy figure is affected by low-Q specimens.

Section 1. PRELIMINARY OPERATING INSTRUCTIONS

3-2 CONTROLS AND INDICATORS

All operating controls and indicators on the capacitance bridge are functionally described in Table 3-1 and are illustrated in Figure 3-1. Reference designations are provided in the second column of the table to facilitate the identification of each item when referring to the schematic diagram. Complete familiarity with the control and indicator functions is recommended before operation of the capacitance bridge is attempted.

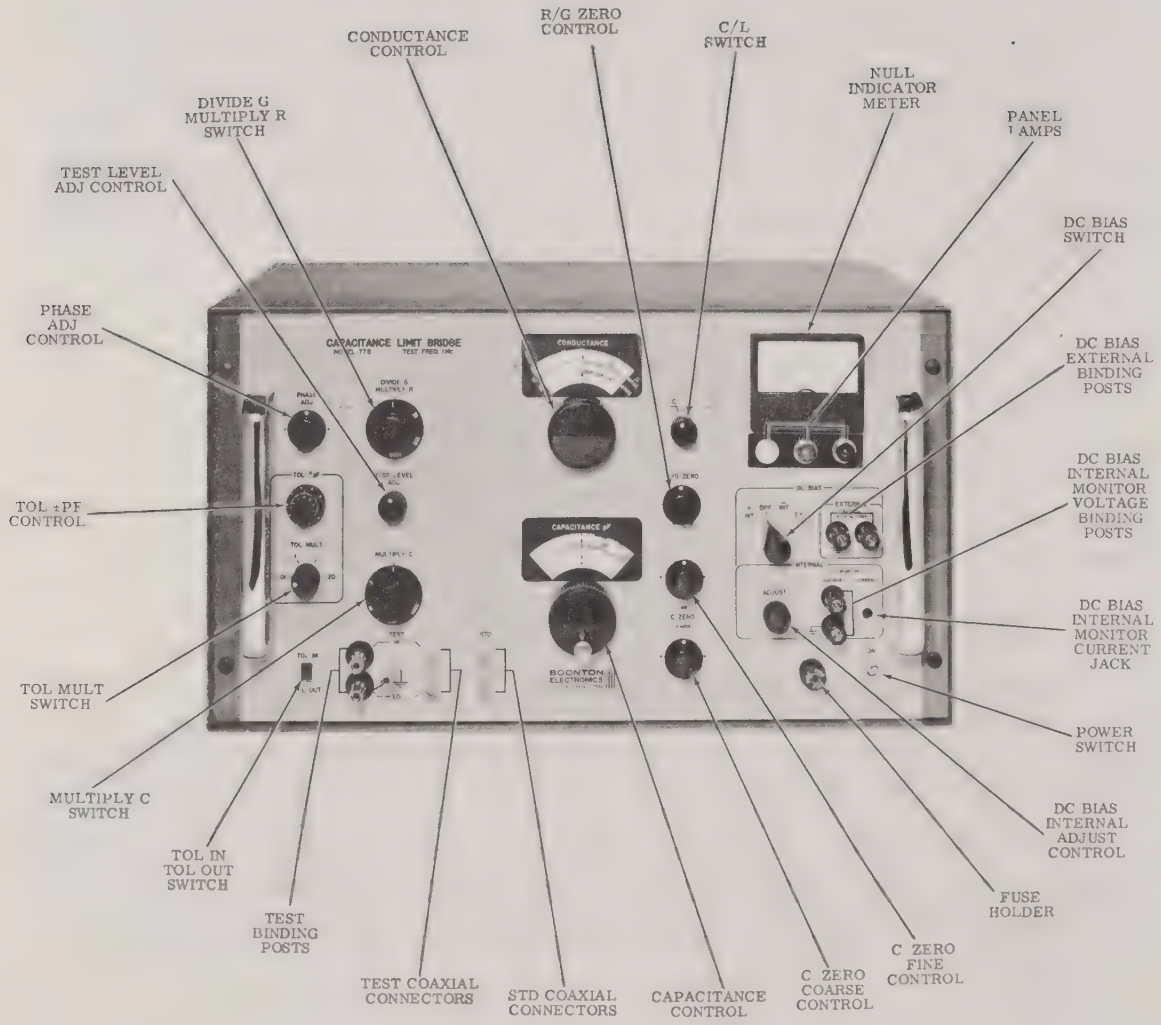


Figure 3-1. Capacitance Bridge Controls and Indicators.

Table 3-1. Controls and Indicators

Item	Ref. Desig.	Description and Function
TOL IN/TOL OUT switch NOTE: On equipment with serial numbers below 185, this switch is designated as AUTO/MANUAL.	S202	Two-position slide switch. TOL IN position used to activate the tolerance amplifier for programmed tests. TOL OUT position used to disable the tolerance amplifier during manual measurements.
TOL ±pF control	R208	Variable resistor with a synchronous 2-scale vernier-counter dial. Outer scale calibrated in pF units and inner scale calibrated in pF decimals. A dial latch is used to lock the control in position. The control establishes a symmetrical dual-limit test tolerance value when the TOL IN/TOL OUT switch (above) is in the TOL IN (or AUTO) position, and is disabled by the TOL OUT (or MANUAL) position. NOTE: On equipment with serial numbers below 185, the MANUAL (e.g., TOL OUT) position does not completely disable the TOL ±pF control. Therefore, set the TOL ±pF control to zero and the TOL MULT switch (see below) to the .01 position during manual measurements.

Table 3-1. Controls and Indicators (Cont.)

Item	Ref. Desig.	Description and Function
TOL MULT switch	S201	Rotary switch with four resistive positions. Used with the TOL ±pF control (above) whose setting is multiplied by the TOL MULT factor. NOTE: The sensitivity of the null indicator circuit is noticeably reduced when the TOL MULT switch is in the 20 position.
CAPACITANCE control	C412	Bridge balancing variable capacitor used to measure values of capacitive specimens. Provides direct readings on two-section dial. Main (upper) dial scale is calibrated in increments of 100 with the first half of each increment coded black and the second half coded red. The vernier (lower) dial section consists of two concentric scales calibrated in increments of 5 which contain unit graduations with 1/5th subdivisions. Readings on the vernier dial outer scale (black numbers) complement the readings obtained on the black coded region of the main dial. Readings on the vernier dial inner scale (red numbers) complement the readings obtained on the red coded region of the main dial.

Table 3-1. Controls and Indicators (Cont.)

Item	Ref. Desig.	Description and Function
MULTIPLY C switch	S401	Rotary switch with five capacitive decade positions on the 77B and four capacitive decade positions on the 77B-S1. Used with the CAPACITANCE control (above) whose reading is multiplied by the MULTIPLY C factor. Serves to expand the CAPACITANCE dial and to facilitate fractional pF measurements.
C ZERO COARSE and FINE controls	C417 C418	Correlated variable capacitors. Used to balance the capacitive portion of the bridge network (with CAPACITANCE dial set at zero).
CONDUCTANCE control	R409	Continuously variable resistor. Initially set at zero when bridge is being balanced. Dual-scale dial provides direct readings of test specimen's conductance and equivalent parallel resistance. G scale is calibrated in μmhos, and R scale is calibrated in ohms.
DIVIDE G/MULTIPLY R switch	S402	Rotary switch with four resistive decade positions. Extends the range of the CONDUCTANCE control by using the switch factor to divide the CONDUCTANCE G-scale reading and to multiply the R-scale reading.

Table 3-1. Controls and Indicators (Cont.)

Item	Ref. Desig.	Description and Function
R/G ZERO control	R412	Variable resistor. Used to balance the resistive portion of the bridge network (with the CONDUCTANCE dial set at zero).
TEST LEVEL ADJ control	R403	Variable resistor. Provides continuous control of test-signal level from 1 mV (fully counterclockwise) to 250 mV (fully clockwise).
PHASE ADJ control	C108	Continuously variable capacitor. Provides the proper phase relationship between reference and test signals so that the detector is insensitive to test specimen losses. (Phase adjustments not required when conductance is balanced out during manual operation.)
C/L switch	S403	Two-position rotary switch. Normally, the C position is used during capacitance measurements and the L position during inductance measurements. However, during phase-sensitive measurements on the 77B (Para. 3-8 and 3-10), the normal switch positions are reversed temporarily to facilitate phasing whenever the MULTIPLY C switch is in the 1 position.

Table 3-1. Controls and Indicators (Cont.)

Item	Ref. Desig.	Description and Function
NULL INDICATOR meter	M101	Amplitude sensitive, null indicating meter. Continuously monitors the output of the bridge.
Panel lamps	DS101 DS102 DS103	Test-decision indicator lamps operated by phase-sensitive detector. A glowing lamp provides the following basic indication during dual- or single-limit testing. Yellow: (DS103) 1. Capacitance of specimen is below tolerance limit. 2. Inductance of specimen is above tolerance limit. Green: (DS101) Value of capacitance or inductance is within tolerance limits. Red: (DS102) 1. Capacitance of specimen is above tolerance limit. 2. Inductance of specimen is below tolerance limit.
DC BIAS: Switch	S501	Four-position rotary switch used to select the following bias voltages: INT+: Internal bias up to +150 volts. OFF: Disables internal bias supply.

Table 3-1. Controls and Indicators (Cont.)

Item	Ref. Desig.	Description and Function
		INT-: Internal bias up to -6 volts. EXT: Disables internal bias supply and connects the bridge to the EXTERNAL binding posts.
EXTERNAL binding posts	---	Used to connect an external bias source (up to 400 V at 100 mA maximum).
INTERNAL ADJUST control	R501	Variable resistor. The 10-revolution control knob adjusts internal dc bias levels from -6 to +150 V when the DC BIAS switch is in the INT+ or INT- position.
INTERNAL MONITOR VOLTAGE binding posts	---	Connections for metering internal bias voltage.
INTERNAL MONITOR CURRENT jack	J501	Connection for metering internal bias current.
Power switch	S301	Toggle switch. Controls ac power applied to capacitance bridge.
Fuse	F301	Protects equipment against ac overloads.
TEST binding posts	---	Used to connect test specimens. The HI and LO binding posts are terminals in the test arm of the bridge. The third binding post is at bridge ground.

Table 3-1. Controls and Indicators (Cont.)

Item	Ref. Desig.	Description and Function
TEST coaxial connectors	J403 J404	BNC test terminals. Inner conductors are in multiple with the corresponding HI/LO binding posts, and the outer conductors are at bridge ground.
STD coaxial connectors	J401 J402	BNC connectors used to measure inductive specimens and to connect external standards or balancing capacitors to the bridge. Inner conductors are the HI and LO terminals in the standard arm of the bridge. Outer conductors are at bridge ground.
Test decision output receptacle	J105	Six-terminal rear-panel receptacle. Terminates test-decision relay contact closures that correspond with front-panel lamp indications. Used to extend relay contact closures to external equipment.
Ac power connector	P302	Three-terminal plug termination on power cable. Connects capacitance bridge to an ac power source.

3-3 STARTING PROCEDURE

Apply ac power to the capacitance bridge by operating the power switch (Fig. 3-1) to the ON position. The panel lamps should indicate a random glow. If the capacitance bridge is to be used for manual measurements, allow 15 minutes for warm-up. Allow one hour warm-up for programmed tests to ensure thermal stabilization of the phase-detector circuit.

3-4 PRELIMINARY ADJUSTMENTS

Perform the preliminary adjustments at the front panel of the capacitance bridge in accordance with Table 3-2.

Table 3-2. Preliminary Adjustments.

Front-Panel Item	Setting or Position
CAPACITANCE main dial and vernier dial	0
CONDUCTANCE G-scale dial	0
MULTIPLY C switch	1
DIVIDE G/MULTIPLY R switch	1000
R/G ZERO control	12 o'clock
C ZERO FINE and COARSE controls	12 o'clock
C/L switch	C
TEST LEVEL ADJ control	Fully clockwise

Table 3-2. Preliminary Adjustments (Cont.)

Front-Panel Item	Setting or Position
PHASE ADJ control	12 o'clock
TOL ± pF dial	0 (locked)
TOL MULT switch	.01
TOL IN/TOL OUT switch (AUTO/MANUAL in some models)	TOL OUT (or MANUAL)
DC BIAS switch	OFF
DC BIAS INTERNAL ADJUST control	Fully counterclockwise
Terminal shield	Installed on TEST binding posts.

3-5 ZERO BALANCING THE BRIDGE

a. General. Zero balancing the bridge is a basic procedure that must be performed before any measurements or tests are made on the capacitance bridge. Perform the zero-balance procedure (b, below) after the preliminary adjustments are completed and whenever any of the following conditions prevail:

1. Each time the capacitance bridge is turned on and has completely warmed up.
2. The setting of the MULTIPLY C switch is changed.
3. The setting of the DIVIDE G/MULTIPLY R switch is changed.
4. The setting of the C/L switch is changed.

5. The setting of the TOL MULT switch is changed.

6. The position of the TEST LEVEL ADJ control is changed.

7. Each time test leads, cables, or a test jig is connected to the capacitance bridge.

8. Each time the terminal shield either is installed on the TEST binding posts or is removed.

b. Zero-Balance Procedure. Be sure that no test specimen is connected to the capacitance bridge and proceed as follows:

1. Adjust the C ZERO COARSE control for a null on the meter. (A lamp threshold crossover also indicates the null.)

2. Adjust the C ZERO FINE control for a null indication.

3. Adjust the R/G ZERO control for a null indication.

4. Repeat steps 1 thru 3 until maximum null is obtained.

NOTE:

If the DIVIDE G/MULTIPLY R switch is in the 1 position, adjust the CONDUCTANCE control for a meter null indication before performing steps 1 thru 4, above.

Section 11. MODEL 77B MANUAL MEASUREMENTS

3-6 GENERAL

When operated in the manual mode, the 77B functions as a precision laboratory bridge and measures capacitance (C), inductance (L), conductance (G), equivalent parallel resistance (R_p), and Q of capacitive or inductive devices. When measuring G or R_p (Para. 3-7j and k or 3-9k and l), use the Figure 3-2 correction curve whenever the MULTIPLY C switch is in the 1 position (to correct for losses due to internal series resistance), and use the Figure 3-3 correction curve if the DIVIDE G/MULTIPLY R switch is in the 1 position.

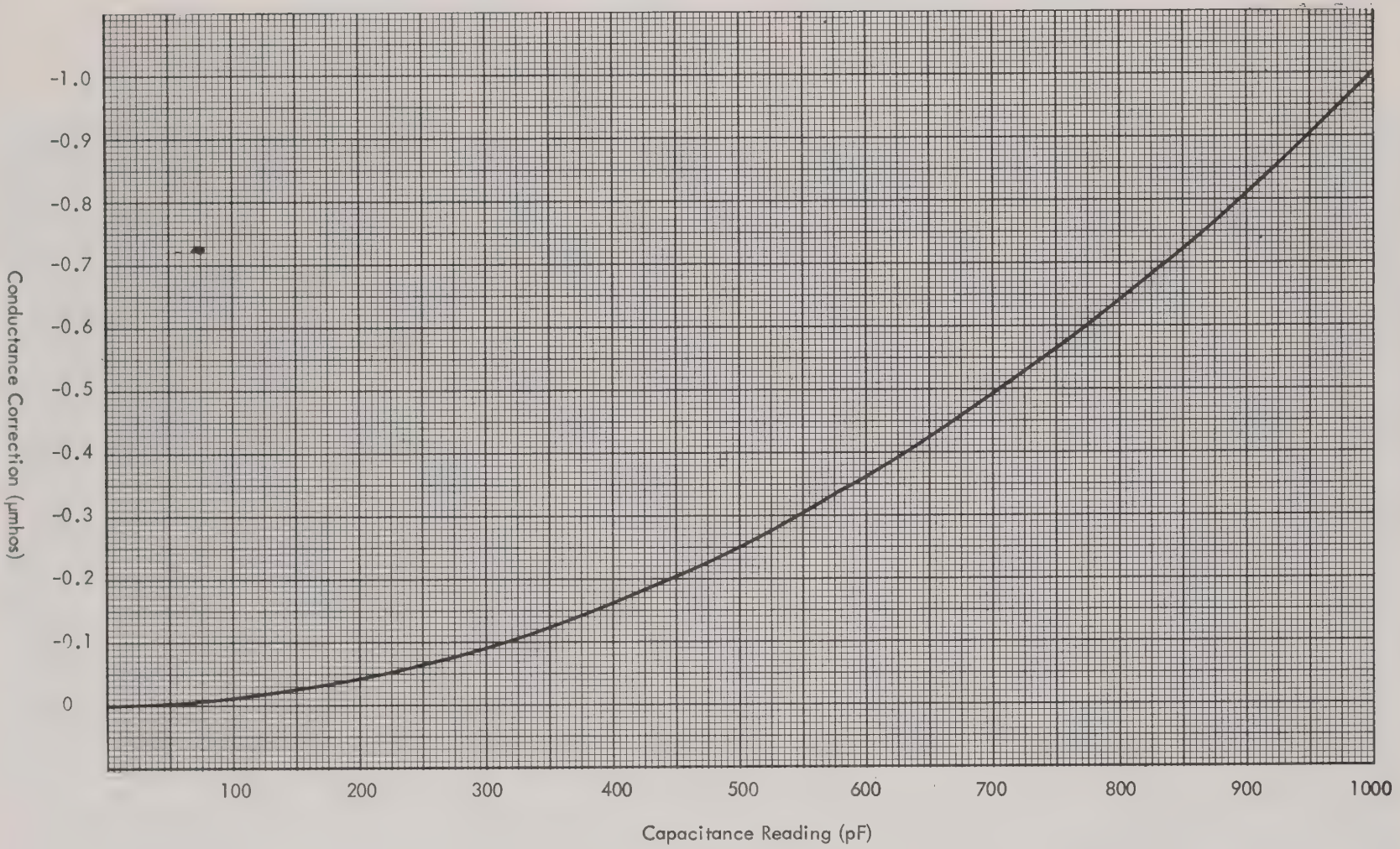


Figure 3-2. Conductance Correction for MULTIPLY C X1 Range.

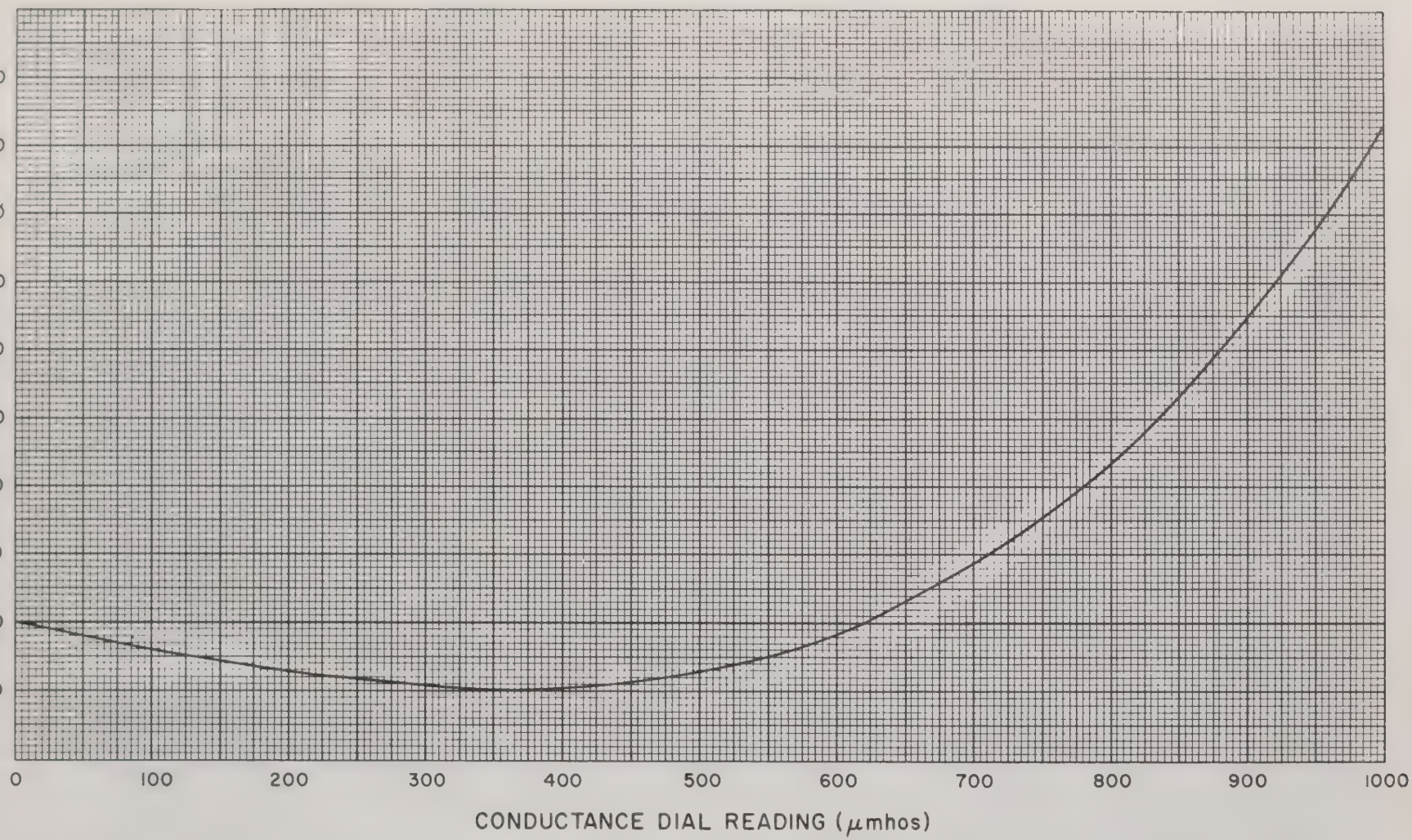


Figure 3-3. Conductance Correction for DIVIDE G/MULTIPLY R X1 Range.

3-7 C, G, R_p, AND Q MEASUREMENTS FOR 77B

Perform the procedure below to measure the C, G, R_p, and Q of capacitive specimens:

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Determine the approximate capacitance value of the test specimen and set the MULTIPLY C switch as indicated in the chart below.

Approximate Value of Test Specimen (pF)	MULTIPLY C Switch Setting
100 to 1000	1
10 to 100	.1
1 to 10	.01
0.1 to 1	.001
0 to 0.1	.0001

c. If the test specimen is to be connected to the TEST binding posts, remove the terminal shield. If test leads or a remote test jig is to be used, connect the coaxial cables to the TEST coaxial connectors.

d. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

e. Connect the test specimen either to the TEST binding posts (use the HI/LO posts for 2-terminal specimens and the HI/LO/⏚ posts for 3-terminal specimens) or to the remote test jig or test leads.

f. Advance the CAPACITANCE control until a lamp threshold crossover occurs (in coincidence with a null on the NULL INDICATOR).

g. Advance the CONDUCTANCE control for a null indication on the meter.

NOTE:

If the meter does not null, set the DIVIDE G/ MULTIPLY R switch to successively lower positions until a null is obtained with the CONDUCTANCE control. Then remove the specimen, set the CAPACITANCE and CONDUCTANCE controls at zero, zero balance the bridge (Para. 3-5b), and perform steps e, f, and g.

h. Repeat steps f, and g, until a complete null is reached.

i. Read the capacitance of the test specimen on the CAPACITANCE dial (times the MULTIPLY C factor).

j. Read the conductance of the test specimen on the G scale of the CONDUCTANCE dial (divided by the DIVIDE G/MULTIPLY R factor).

k. Read the parallel resistance of the test specimen on the R scale of the CONDUCTANCE dial (times the DIVIDE G/MULTIPLY R factor).

l. If required, calculate the Q of the test specimen by using the following equation:

$$Q = \frac{6.28\ C}{G}$$

Where

C = capacitance in pF

G = conductance in μmhos

3-8 PHASE-SENSITIVE CAPACITANCE MEASUREMENT FOR 77B

The following procedure measures capacitance by phasing-out the resistive component introduced by the test specimen so that the panel-lamp indicators are insensitive to R_p.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If the test specimen is to be connected to the TEST binding posts, remove the terminal shield. If a remote test jig or test leads are to be used, connect the coaxial cables to the TEST coaxial connectors.

c. Determine the approximate capacitance value of the test specimen and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. (Do not adjust the CONDUCTANCE control.)

Approximate Value of Test Specimen (pF)	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch	CONDUCTANCE Control G Scale
100 to 1000	1	1	L	+1000
10 to 100	.1	1	C	-100*
1 to 10	.01	10	C	-100*
0 to 1	.001	100	C	-100*

* Tenth subdivision on G scale to the left of zero.

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Refer to the chart in step c, above, and adjust the CONDUCTANCE control to the required position.

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. If the C/L switch is at L, set it to the C position.

j. Zero balance the bridge (Para. 3-5b).

k. Connect the test specimen either to the TEST binding posts (use the HI/LO post for 2-terminal specimens and the HI/LO/⏚ posts for 3-terminal specimens) or to the remote test jig or test leads.

l. Advance the CAPACITANCE control until the panel-lamp threshold crossover occurs.

m. Read the capacitance of the test specimen on the CAPACITANCE dial (times the MULTIPLY C factor).

3-9 L, G, R_p, AND Q MEASUREMENTS FOR 77B

Although the 77B is calibrated in capacitance, it accurately measures inductance (L) when capacitance readings are translated to inductance values by the simple computation given in the procedure below. Perform the following procedure to measure L, as well as the G, R_p, and Q of inductive specimens.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If plug adapters, test leads, or a remote test jig is to be used, connect the item to the STD coaxial connectors.

c. Determine the approximate inductance of the test specimen and set the MULTIPLY C switch in accordance with the chart below.

Approximate Value of Test Specimen	MULTIPLY C Switch Setting
25 μH to 250 μH	1
250 μH to 2.5 mH	.1
2.5 mH to 25 mH	.01

d. Set the C/L switch to the L position.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Connect the test specimen to the STD coaxial connectors or to the plug adapters, test leads, or remote test jig.

g. Advance the CAPACITANCE control until a lamp threshold crossover occurs.

h. Advance the CONDUCTANCE control for a null indication on the meter.

NOTE:

If the meter does not null, set the DIVIDE G/MULTIPLY R switch to successively lower positions until a null is obtained with the CONDUCTANCE control. Then remove the specimen, set the CAPACITANCE and CONDUCTANCE controls at zero, zero balance the bridge (Para. 3-5b), and perform steps f, g, and h.

i. Repeat steps g, and h until a complete null is reached.

j. Read the value on the CAPACITANCE dial and convert the pF value to mH using the following equation:

$$L = \frac{25.33}{C}$$

Where

L = inductance in mH

C = CAPACITANCE dial reading (times the MULTIPLY C factor)

k. Read the conductance of the test specimen on the G scale of the CONDUCTANCE dial (divided by the DIVIDE G/MULTIPLY R factor).

l. Read the equivalent parallel resistance of the test specimen on the R scale of the CONDUCTANCE dial (times the DIVIDE G/MULTIPLY R factor).

m. If required, calculate the Q of the test specimen by using the following equation:

$$Q = \frac{159.2}{LG}$$

Where

L = inductance in mH

G = conductance in μmhos

3-10 PHASE-SENSITIVE INDUCTANCE MEASUREMENT FOR 77B

The following procedure measures inductance by phasing out the resistive component introduced by the test specimen so that the panel-lamp indicators are insensitive to R_p.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If plug adapters, test leads, or a remote test jig is to be used, connect the item to the STD coaxial connectors.

c. Determine the approximate inductance value of the test specimen and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. (Do not adjust the CONDUCTANCE control.)

Approximate Value of Test Specimen	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch	CONDUCTANCE Control G Scale
25 μH to 250 μH	1	1	C	+1000
250 μH to 2.5 mH	.1	1	L	-100*
2.5 mH to 25 mH	.01	10	L	-100*

* Tenth subdivision on G scale to the left of zero

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Refer to the chart in step c, above, and adjust the CONDUCTANCE control to the required position.

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. If the C/L switch is at C, set it to the L position.

j. Zero balance the bridge (Para. 3-5b).

k. Connect the test specimen to the STD coaxial connectors or to the plug adapters, test leads, or remote test jig.

l. Advance the CAPACITANCE control until a lamp threshold crossover occurs.

m. Read the value on the CAPACITANCE dial and convert the pF value to mH using the following equation:

$$L = \frac{25.33}{C}$$

Where

L = inductance in mH

C = CAPACITANCE dial reading (times the MULTIPLY C factor)

Section 111. MODEL 77B PROGRAMMED TESTS

3-11 GENERAL

a. The programmed-test mode is used to test and sort capacitors, inductors, or semiconductor devices during production testing, incoming inspection, quality assurance, or similar applications. This section contains procedures to program the 77B for either single-limit or dual-limit tests on a go/no-go basis. The 77B can be used in semiautomatic operation, whereby test specimens are hand fed either at a remote test jig or at the front-panel TEST terminals; or the 77B can be connected into an automatic, high-speed system to test and sort axial-lead specimens.

b. Figure 3-4 illustrates a Boonton Electronics automatic testing and sorting system which consists of the 77B or 77B-S1, a Model 850B Component Feeder, and a Model 52-8A Control Unit. In this typical testing and sorting configuration, the 77B automatically performs high-speed tests, issues test-decision signals to the control unit, and provides the operator with go/no-go test-lamp indications as the component feeder automatically sorts specimens into high, low, or go bins.

c. The 77B is programmed to perform either automatic or semiautomatic tests when the applicable dual-limit or single-limit procedure in this section is completed.

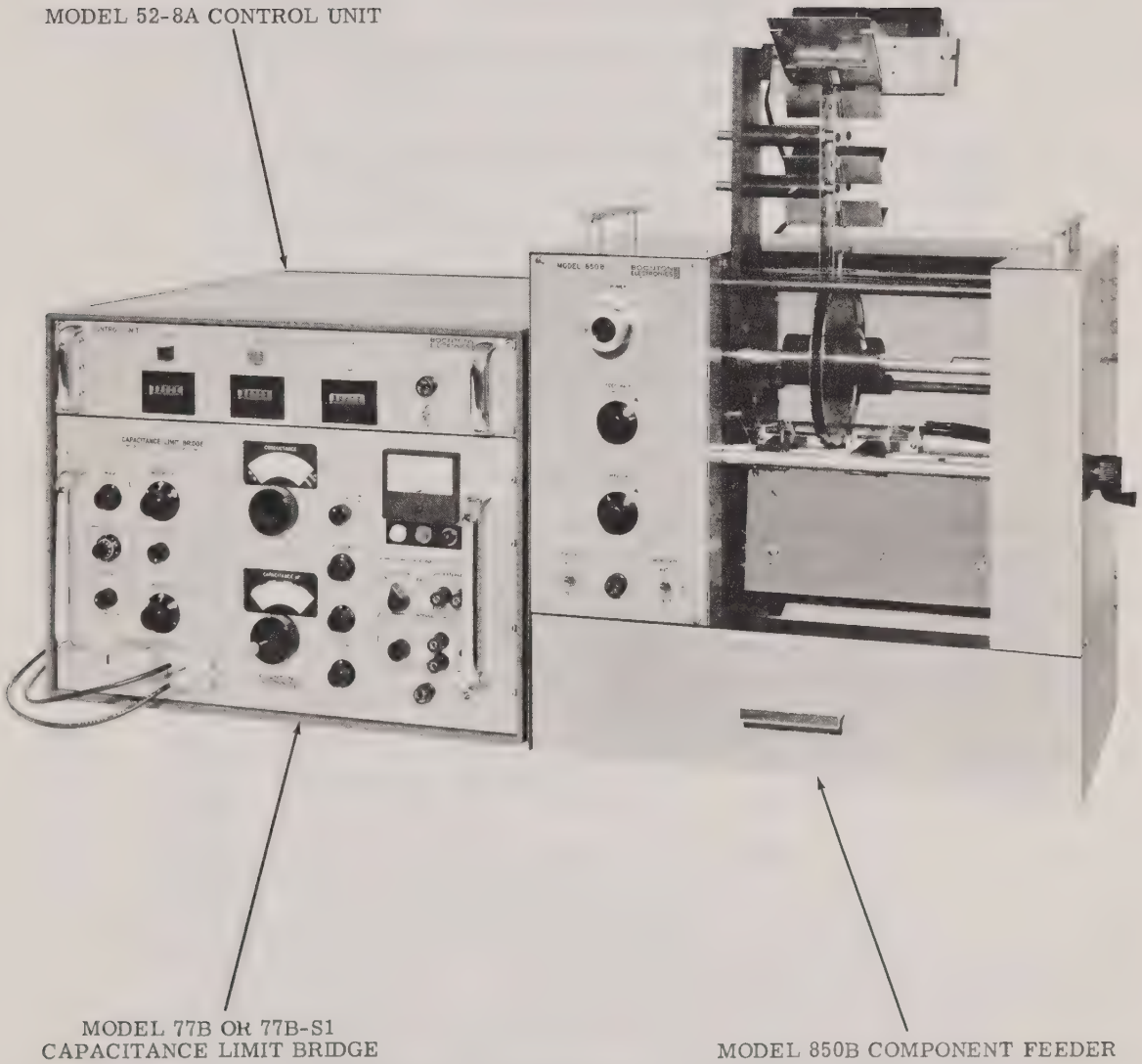


Figure 3-4. Typical Automatic Testing and Sorting System.

3-12 DUAL-LIMIT CAPACITANCE TEST FOR 77B

Symmetrical upper and lower limits are programmed into the 77B in this procedure, and a panel-lamp readout indicates whether the capacitance of each test specimen is high, low, or within tolerance.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the TEST HI/LO coaxial connectors on the front panel.

c. Determine the nominal value of the test specimens and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. (Do not adjust the CONDUCTANCE control.)

Nominal Value of Test Specimen (pF)	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch	CONDUCTANCE Control G Scale
100 to 1000	1	1	L	+1000
10 to 100	.1	1	C	-100*
1 to 10	.01	10	C	-100*
0 to 1	.001	100	C	-100*

* Tenth subdivision on G scale to the left of zero

d. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

e. Refer to the chart in step c, above, and adjust the CONDUCTANCE control to the required position.

f. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

g. Return the CONDUCTANCE control to zero on the dial's G scale.

h. If the C/L switch is at L, set it to the C position.

i. If the specimen's tolerance is in percentage, convert it to a pF value. (For example, a 75 pF capacitance with a ±5% tolerance converts to ±3.75 pF.)

j. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20. For any other MULTIPLY C switch position, select a TOL MULT position appropriate for the tolerance value derived in step i. (For the above example, the TOL MULT switch would be set to 1.)

k. Zero balance the bridge (Para. 3-5b).

l. Release the TOL ±pF control by pushing the dial latch to the up position and dialing the required pF tolerance value. Lock the TOL ±pF control by holding the dial steady and pushing the dial latch to the down position.

NOTE:

If a tolerance accuracy better than 1% is required, perform the procedure in Paragraph 3-16 before proceeding to step m.

m. Set the TOL IN/TOL OUT switch to TOL IN.

n. Advance the CAPACITANCE control to the nominal value of the test specimens.

o. The 77B now is programmed to perform its symmetrical dual-limit testing functions. As specimens are fed to the capacitance bridge, the green lamp indicates that the value of a test specimen is within tolerance, the yellow lamp indicates that the capacitance of the specimen is less than the lower limit, and the red lamp indicates that the capacitance of the specimen exceeds the upper limit.

3-13 SINGLE-LIMIT CAPACITANCE TEST FOR 77B

Only one limit is programmed into the 77B in this procedure, and a panel-lamp readout indicates whether or not each test specimen is within tolerance.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the TEST HI/LO coaxial connectors on the front panel.

c. Determine the required limit value and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. (Do not adjust the CONDUCTANCE control.) If the tolerance is in percentage, convert it to pF values and algebraically add the required tolerance to the nominal value of the specimen. (For example, a ±5% tolerance for a nominal 100 pF capacitor converts to ±5 pF and to 105 pF if the upper limit is required or to 95 pF if the lower limit is required.)

Limit Value (pF)	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch	CONDUCTANCE Control G Scale
100 to 1000	1	1	L	+1000
10 to 100	.1	1	C	-100*
1 to 10	.01	10	C	-100*
0 to 1	.001	100	C	-100*

* Tenth subdivision on G scale to the left of zero

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Refer to the chart in step c, above, and adjust the CONDUCTANCE control to the required position.

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. If the C/L switch is at L, set it to the C position.

j. Zero balance the bridge (Para. 3-5b).

k. Advance the CAPACITANCE control to the required limit value. (For the 105 pF upper limit in the example above, the MULTIPLY C switch would be in the 1 position and the CAPACITANCE control would be advanced to 100 on the upper dial and to 5 on the lower dial. If the lower limit were required, the CAPACITANCE control would be advanced to 95 on the lower dial.)

l. The 77B now is programmed to perform its single-limit testing functions. The yellow lamp indicates that a test specimen is lower in capacitance than the programmed limit, and the red lamp indicates that the specimen is higher in capacitance than the programmed limit. Thus, if the upper limit is being used, a glowing yellow lamp indicates that the specimen is within tolerance, and a glowing red lamp warns that the capacitance of the specimen exceeds the programmed limit. If the lower limit is being used, a glowing red lamp indicates that the specimen is within tolerance, and a glowing yellow lamp warns that the capacitance of the specimen is less than the programmed limit.

3-14 DUAL-LIMIT INDUCTANCE TEST FOR 77B

The 77B basically is a capacitance bridge, and it tests inductive specimens in terms of equivalent capacitance. In the following procedure, an equation is used to convert the test specimen's nominal inductance to a nominal capacitance value, and then the percentage tolerance is converted to equivalent pF values. Since the symmetrical

relationship of the inductance tolerance to the nominal inductance is not retained when these values are converted to capacitance, the equation provides an adjusted nominal capacitance value that perpetuates symmetry. It should be noted that out-of-tolerance lamp indications for inductance tests are the reverse of those obtained during capacitance tests.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the STD HI/LO coaxial connectors on the front panel.

c. Determine the nominal value of the test specimens and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. (Do not adjust the CONDUCTANCE control.)

Nominal Value of Test Specimen	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch	CONDUCTANCE Control G Scale
25 μH to 250 μH	1	1	C	+1000
250 μH to 2.5 mH	.1	1	L	-100*
2.5 mH to 25 mH	.01	10	L	-100*

* Tenth subdivision on G scale to the left of zero

d. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

e. Refer to the chart in step c, above, and adjust the CONDUCTANCE control to the required position.

f. Adjust the PHASE ADJ control for a lamp threshold–crossover indication.

g. Return the CONDUCTANCE control to zero on the G scale.

h. If the C/L switch is at C, set it to the L position.

i. Determine the specimen's tolerance both in percentage and in mH values. (For example, a ± 5% tolerance for a nominal 0.4 mH inductor = ± 0.02 mH.)

j. Use the following equation to convert the specimen's nominal inductance to an adjusted nominal capacitance value:

$$C = \frac{25.33L}{L^2 - (\triangle L)^2}$$

Where

C = adjusted nominal capacitance in pF

L = nominal inductance in mH

$\triangle L$ = ± inductance tolerance in mH

(For the step i example the 0.4 mH inductance converts to $\frac{25.33\ (0.4)}{(0.4)^2 - (0.02)^2}$ = 63.48 pF adjusted nominal capacitance.)

k. Convert the specimen's percentage tolerance to equivalent pF values. (In the above example, ± 5% of the 63.48 pF adjusted nominal = ± 3.174 pF capacitance tolerance.)

l. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20. For any other MULTIPLY C switch position, select a TOL MULT position appropriate for the tolerance value derived in step k. (For the step k example, the TOL MULT switch would be set to 1.)

m. Zero balance the bridge (Para. 3-5b).

n. Release the TOL ±pF control by pushing the dial latch to the up position. Dial in the capacitance tolerance value derived in step k and lock the TOL ±pF control by holding the dial steady and pushing the dial latch to the down position. (For the step k example, 3 would be dialed on the outer scale and 1.74 on the inner decimal scale, since 3.174 x 1 = 3.174 pF.)

NOTE:

If a tolerance accuracy better than 1% is required, perform the procedure in Paragraph 3-16 before proceeding to step o.

o. Set the TOL IN/TOL OUT switch to TOL IN.

p. Advance the CAPACITANCE control to the adjusted nominal capacitance value that was derived in step j. (For the step j example, the MULTIPLY C switch would be in the .1 position and the CAPACITANCE control would be advanced to 600 on the upper dial and to 34.8 on the lower dial.)

q. The 77B now is programmed to perform its dual-limit testing functions. The green lamp indicates that the value of a test specimen is within tolerance, the yellow lamp indicates that the inductance of the specimen exceeds the programmed upper limit, and the red lamp indicates that the inductance of the specimen is less than the programmed lower limit.

3-15 SINGLE-LIMIT INDUCTANCE TEST FOR 77B

Only one limit is programmed into the 77B in this procedure. Inductive specimens are tested in terms of equivalent capacitance, and a panel-lamp readout indicates whether or not each specimen is within tolerance. (Note that the out-of-tolerance lamp indications for inductance tests are the reverse of those obtained during capacitance tests.)

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the STD HI/LO coaxial connectors on the front panel.

c. Determine the required limit value and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. (Do not adjust the CONDUCTANCE control.) If the tolerance is in percentage, convert it to mH

values and algebraically add the required tolerance to the nominal value of the specimen. (For example, a ±5% tolerance for a nominal 0.4 mH inductor is equivalent to ±0.02 mH, or 0.42 mH if the upper limit is required and 0.38 mH if the lower limit is required.)

Limit Value	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch	CONDUCTANCE Control G Scale
25 μH to 250 μH	1	1	C	+1000
250 μH to 2.5 mH	.1	1	L	-100*
2.5 mH to 25 mH	.01	10	L	-100*

* Tenth subdivision on G scale to the left of zero

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20.

e. Zero balance the bridge in accorance with the procedure in Paragraph 3-5b.

f. Refer to the chart in step c, above, and adjust the CONDUCTANCE control to the required position.

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. If the C/L switch is at C, set it to the L position.

j. Zero balance the bridge (Para. 3-5b).

k. Use the following equation to convert the inductance limit value to an equivalent pF value:

$$C = \frac{25.33}{L}$$

Where

C = capacitance in pF

L = inductance in mH

(If the upper limit were required in the example given in step c, 0.42 mH would convert to 60.31 pF. If the lower limit were required, 0.38 mH would convert to 66.66 pF.)

l. Advance the CAPACITANCE control to the pF value derived in step k, above. (For the upper limit in the example above, the MULTIPLY C switch would be in the .1 position, and the CAPACITANCE control would be advanced to 600 on the upper dial and to 3.1 on the lower dial. If the lower limit were required, the CAPACITANCE control would be advanced to 600 on the upper dial and to 66.6 on the lower dial.)

m. The 77B now is programmed to perform its single-limit testing functions. The yellow lamp indicates that a test specimen is higher in inductance than the programmed limit, and the red lamp indicates that the specimen is lower in inductance than the programmed limit. Thus, if the lower limit is being used, a glowing yellow lamp indicates that the specimen is within tolerance, and a glowing red lamp warns that the inductance of the specimen is less than the programmed limit. If the upper limit is being used, a glowing red lamp indicates that the specimen is within tolerance, and a glowing yellow lamp warns that the inductance of the specimen exceeds the programmed limit.

3-16 OPTIMIZING TOLERANCE ACCURACY

The 1% accuracy of the tolerance circuit can be increased to 0.25% which is the basic accuracy of the 77B (Para. 1-4a and b). For optimum tolerance accuracy during dual-limit testing, perform the following procedure after the required pF tolerance value has been programmed into the TOL ±pF control in Paragraphs 3-12 l or 3-14 n.

a. Set the CAPACITANCE control upscale to the tolerance value derived in Paragraph 3-12 i or in Paragraph 3-14 k, as applicable.

b. Release the dial latch on the TOL ±pF control and slowly turn the control back and forth until the panel-lamp glow just transfers from yellow to green.

c. Lock the TOL ±pF control by holding the dial steady and pushing the dial latch to the down position.

d. Perform the remainder of the dual-limit test procedure.

Section IV. MANUAL MEASUREMENTS FOR MODEL 77B-S1

3-17 GENERAL

When operated in the manual mode, the 77B-S1 functions as a precision laboratory bridge and measures capacitance (C), inductance (L), conductance (G), equivalent parallel resistance (R_p), and Q of capacitive or inductive devices. When measuring G or R_p (Para. 3-18i and k or 3-20k and l), refer to the Figure 3-3 correction curve whenever the DIVIDE G/MULTIPLY R switch is in the 1 position.

3-18 C, G, R_p, AND Q MEASUREMENTS FOR 77B-S1

Perform the procedure below to measure the C, G, R_p, and Q of capacitive specimens:

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If the test specimen is to be connected to the TEST binding posts, remove the terminal shield. If test leads or a remote test jig is to be used, connect the coaxial cables to the TEST coaxial connectors.

c. Determine the approximate capacitance value of the test specimen and set the MULTIPLY C switch as indicated in the chart below.

Approximate Value of Test Specimen (pF)	MULTIPLY C Switch Setting
100 to 1000	1
10 to 100	.1
1 to 10	.01
0 to 1	.001

d. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

e. Connect the test specimen either to the TEST binding posts (use the HI/LO posts for 2-terminal specimens and the HI/LO/⏚ posts for 3-terminal specimens) or to the remote test jig or test leads, as required.

f. Advance the CAPACITANCE control until a lamp threshold crossover occurs.

g. Advance the CONDUCTANCE control for a null indication on the meter.

NOTE:

If the meter does not null, set the DIVIDE G/MULTIPLY R switch to successively lower positions until a null is obtained with the CONDUCTANCE control. Then remove the specimen, set the CAPACITANCE and CONDUCTANCE controls at zero, zero balance the bridge (Para. 3-5b), and perform steps e, f, and g, above.

h. Repeat steps f and g until a complete null is reached.

i. Read the capacitance of the test specimen on the CAPACITANCE dial (times the MULTIPLY C factor).

j. Read the conductance of the test specimen on the G scale of the CONDUCTANCE dial (divided by the DIVIDE G/ MULTIPLY R factor).

k. Read the parallel resistance of the test specimen on the R scale of the CONDUCTANCE dial (times the DIVIDE G/ MULTIPLY R factor).

l. If required, calculate the Q of the test specimen by using the following equation:

$$Q = \frac{0.628\ C}{G}$$

Where

C = capacitance in pF

G = conductance in μmhos

3-19 PHASE-SENSITIVE CAPACITANCE MEASUREMENT FOR 77B-S1

The following procedure measures capacitance by phasing out the resistive component introduced by the test specimen so that the panel-lamp indicators are insensitive to R_p.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If the test specimen is to be connected to the TEST binding posts, remove the terminal shield. If a remote test jig or test leads are to be used, connect the coaxial cables to the TEST coaxial connectors.

c. Determine the approximate capacitance value of the test specimen and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below.

Approximate Value of Test Specimen (pF)	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch
100 to 1000	1	1	C
10 to 100	.1	10	C
1 to 10	.01	100	C
0 to 1	.001	1000	C

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20 and the DIVIDE G/MULTIPLY R switch to 1.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Set the CONDUCTANCE control to the -100 position (tenth subdivision on G scale to the left of zero).

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. Zero balance the bridge (Para. 3-5b).

j. Connect the test specimen either to the TEST binding posts (use the HI/LO posts for 2-terminal specimens and the HI/LO/⏚ posts for 3-terminal specimens) or to the remote test jig or test leads, as required.

k. Advance the CAPACITANCE control until the panel-lamp threshold crossover occurs.

l. Read the capacitance of the test specimen on the CAPACITANCE dial (times the MULTIPLY C factor).

3-20 L, G, R_p, AND Q MEASUREMENTS FOR 77B-S1

Although the 77B-S1 is calibrated in capacitance, it accurately measures inductance (L) when capacitance readings are translated to inductance values by the simple computation given in the procedure below. Perform the following procedure to measure L, as well as the G, R_p, and Q of inductive specimens.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If plug adapters, test leads, or a remote test jig is to be used, connect the item to the STD coaxial connectors.

c. Determine the approximate inductance of the test specimen and set the MULTIPLY C switch as indicated in the following chart.

Approximate Value of Test Specimen	MULTIPLY C Switch Setting
2.5 mH to 25 mH	1
25 mH to 250 mH	.1

d. Set the C/L switch to the L position.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Connect the test specimen to the STD coaxial connectors or to the plug adapters, test leads, or remote test jig.

g. Advance the CAPACITANCE control until a lamp threshold crossover occurs.

h. Advance the CONDUCTANCE control for a null indication on the meter.

NOTE:

If the meter does not null, set the DIVIDE G/MULTIPLY R switch to successively lower positions until a null is obtained with the CONDUCTANCE control. Then remove the specimen, set the CAPACITANCE and CONDUCTANCE controls at zero, zero balance the bridge (Para. 3-5b), and perform steps f, g, and h, above.

i. Repeat steps g and h until a complete null is reached.

j. Read the value on the CAPACITANCE dial and convert the pF value to mH using the following equation:

$$L = \frac{2533}{C}$$

Where

L = inductance in mH

C = CAPACITANCE dial reading (times the MULTIPLY C factor)

k. Read the conductance of the test specimen on the G scale of the CONDUCTANCE dial (divided by the DIVIDE G/MULTIPLY R factor).

l. Read the parallel resistance of the test specimen on the R scale of the CONDUCTANCE dial (times the DIVIDE G/MULTIPLY R factor).

m. If required, calculate the Q of the test specimen by using the following equation:

$$Q = \frac{1592}{LG}$$

Where

L = inductance in mH

G = conductance in μmhos

3-21 PHASE-SENSITIVE INDUCTANCE MEASUREMENT FOR 77B-S1

The following procedure measures inductance by phasing out the resistive component introduced by the test specimen so that the panel-lamp indicators are insensitive to R_p.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. If plug adapters, test leads, or a remote test jig is to be used, connect the item to the STD coaxial connectors.

c. Determine the approximate inductance value of the test specimen and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below.

Approximate Value of Test Specimen	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch
2.5 mH to 25 mH	1	1	L
25 mH to 250 mH	.1	10	L

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20 and the DIVIDE G/MULTIPLY R switch to 1.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Set the CONDUCTANCE control to the -100 position (tenth subdivision on G scale to the left of zero).

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. Zero balance the bridge (Para. 3-5b).

j. Connect the test specimen to the STD coaxial connectors or to the plug adapters, test leads, or remote test jig.

k. Advance the CAPACITANCE control until a lamp threshold crossover occurs.

l. Read the value of the CAPACITANCE dial and convert the pF value to mH using the following equation:

$$L = \frac{2533}{C}$$

Where

L = inductance in mH

C = CAPACITANCE dial reading (times the MULTIPLY C factor)

Section V. MODEL 77B-S1 PROGRAMMED TESTS

3-22 GENERAL

a. The programmed-test mode is used to test and sort capacitors, inductors, or semiconductor devices during production testing, incoming inspection, quality assurance, or similar applications. This section contains procedures to program the 77B-S1 for either single-limit or dual-limit tests on a go/no-go basis. The 77B-S1 can be used in semiautomatic operation, whereby test specimens are hand-fed either at a remote test jig or at the front-panel TEST terminals; or the 77B-S1 can be connected into an automatic, high-speed system to test and sort axial-lead specimens.

b. Figure 3-4 illustrates a Boonton Electronics automatic testing and sorting system which consists of a 77B or 77B-S1, a Model 850B Component Feeder, and a Model 52-8A Control Unit. In this typical testing and sorting configuration, the 77B-S1 automatically performs high-speed tests, issues test-decision signals to the control unit, and provides the operator with go/no-go test-lamp indications as the component feeder automatically sorts specimens into high, low, or go bins.

c. The 77B-S1 is programmed to perform either automatic or semiautomatic tests when the applicable dual-limit or single-limit procedure in this section is completed.

3-23 DUAL-LIMIT CAPACITANCE TEST FOR 77B-S1

Symmetric upper and lower limits are programmed into the 77B-S1 in this procedure, and a panel-lamp readout indicates whether the capacitance of each test specimen is high, low, or within tolerance.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the TEST HI/LO coaxial connectors on the front panel.

c. Determine the nominal value of the test specimens and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below.

Nominal Value of Test Specimen (pF)	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch
100 to 1000	1	1	C
10 to 100	.1	10	C
1 to 10	.01	100	C
0 to 1	.001	1000	C

d. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

e. Set the CONDUCTANCE control to the -100 position (tenth subdivision on G scale to the left of zero).

f. Adjust the PHASE ADJ control for lamp threshold-crossover indication.

g. Return the CONDUCTANCE control to zero on the G scale.

h. Convert the specimen's percentage tolerance to a pF value. (For example, a 75 pF capacitance with a ±5% tolerance converts to ±3.75 pF.)

i. Perform the applicable step below:

(1) If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20 and the DIVIDE G/MULTIPLY R switch to 1.

(2) For any other MULTIPLY C position, select a TOL MULT setting appropriate for the tolerance value derived in step h. (For the example above, the TOL MULT switch would be set to 1.) However, if the TOL MULT 20 position is selected when the MULTIPLY C switch is in the .1 position, set the DIVIDE G/MULTIPLY R switch to 1, set the CONDUCTANCE control to -10, and repeat steps f and g.

j. Zero balance the bridge (Para. 3-5b).

k. Release the TOL ±pF control by pushing the dial latch to the up position and dial in the required pF tolerance value. Lock the TOL ±pF control by holding the dial steady and pushing the dial latch to the down position.

NOTE:

If a tolerance accuracy better than 1% is required, perform the procedure in Paragraph 3-27 before proceeding to step l, below.

l. Set the TOL IN/TOL OUT switch to TOL IN.

m. Advance the CAPACITANCE control to the nominal value of the test specimens.

n. The 77B-S1 now is programmed to perform its symmetrical dual-limit testing functions. The green lamp indicates that the value of a test specimen is within tolerance, the yellow lamp indicates that the capacitance of the specimen is less than the lower limit, and the red lamp indicates that the capacitance of the specimen exceeds the upper limit.

3-24 SINGLE-LIMIT CAPACITANCE TEST FOR 77B-S1

Only one limit is programmed into the 77B-S1 in this procedure, and a panel-lamp readout indicates whether or not each test specimen is within tolerance.

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the TEST HI/LO coaxial connectors on the front panel.

c. Determine the required limit value and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. If the tolerance is in percentage, convert it to pF values and algebraically add the required tolerance to the nominal value of the specimen. (For example, a ±5% tolerance for a nominal 100 pF capacitor converts to ±5 pF and to 105 pF if the upper limit is required or to 95 pF if the lower limit is required.)

Limit Value (pF)	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch
100 to 1000	1	1	C
10 to 100	.1	10	C
1 to 10	.01	100	C
0 to 1	.001	1000	C

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20 and the DIVIDE G/MULTIPLY R switch to 1.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Set the CONDUCTANCE control to the -100 position (tenth subdivision on G scale to the left of zero).

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. Zero balance the bridge (Para. 3-5b).

j. Advance the CAPACITANCE control to the required limit value. (For the 105 pF upper limit in the step c example, the MULTIPLY C switch would be in the 1 position and the CAPACITANCE control would be advanced to 100 on the upper dial and to 5 on the lower dial. If the lower limit were required, the CAPACITANCE control would be advanced to 95 on the lower dial.)

k. The 77B-S1 now is programmed to perform its single-limit testing functions. The yellow lamp indicates that a test specimen is lower in capacitance than the programmed limit, and the red

lamp indicates that the specimen is higher in capacitance than the programmed limit. Thus, if the upper limit is being used, a glowing yellow lamp indicates that the specimen is within tolerance, and a glowing red lamp warns that the capacitance of the specimen exceeds the programmed limit. If the lower limit is being used, a glowing red lamp indicates that the specimen is within tolerance, and a glowing yellow lamp warns that the capacitance of the specimen is less than the programmed limit.

3-25 DUAL-LIMIT INDUCTANCE TEST FOR 77B-S1

The 77B-S1 basically is a capacitance bridge, and it tests inductive specimens in terms of equivalent capacitance. In the following procedure, an equation is used to convert the test specimen's nominal inductance to a nominal capacitance value, and then the percentage tolerance is converted to equivalent pF values. Since the symmetrical relationship of the inductance tolerance to the nominal inductance is not retained when these values are converted to capacitance, the equation provides an adjusted nominal capacitance value that perpetuates symmetry. (It should be noted that out-of-tolerance lamp indications for inductance tests are the reverse of those obtained during capacitance tests.)

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the STD HI/LO coaxial connectors on the front panel.

c. Determine the nominal value of the test specimens and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below.

Nominal Value of Test Specimen	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch
2.5 mH to 25 mH	1	1	L
25 mH to 250 mH	.1	10	L

d. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

e. Set the CONDUCTANCE control to the -100 position (tenth subdivision on G scale to the left of zero).

f. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

g. Return the CONDUCTANCE control to zero on the G scale.

h. Determine the specimen's tolerance both in percentage and in mH values. (For example, a ± 5% tolerance for a nominal 40 mH inductor is ± 2 mH.)

i. Use the following equation to convert the specimen's nominal inductance to an adjusted nominal capacitance value:

$$C = \frac{2533L}{L^2 - (\Delta L)^2}$$

Where

C = adjusted nominal capacitance in pF

L = nominal inductance in mH

ΔL = ± inductance tolerance in mH

(For the step h example, the 40 mH inductance converts to $\frac{2533\ (40)}{(40)^2 - (2)^2}$ = 63.48 pF adjusted nominal capacitance.)

j. Convert the specimen's percentage tolerance to equivalent pF values. (In the above example, ± 5% of 63.48 pF = ± 3.174 pF capacitance tolerance.)

k. Perform the applicable step below:

(1) If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20 and the DIVIDE G/MULTIPLY R switch to 1.

(2) If the MULTIPLY C switch is in the .1 position, select a TOL MULT setting appropriate for the tolerance value derived in step j. However, if the TOL MULT 20 position is selected, set the DIVIDE G/MULTIPLY R switch to 1, set the CONDUCTANCE control to -10, and repeat steps f and g. (For the step j example, the TOL MULT switch would be set to 1.)

l. Zero balance the bridge (Para. 3-5b).

m. Release the TOL ±pF control by pushing the dial latch to the up position. Dial in the capacitance tolerance value derived in step j and lock the TOL ±pF control by holding the dial steady and pushing the dial latch to the down position. (For the step j example, 3 would be dialed on the outer scale and 1.74 on the inner decimal scale, since 3.174 x 1 = 3.174 pF.)

NOTE:

If a tolerance accuracy better than 1% is required, perform the procedure in Paragraph 3-27 before proceeding to step n below.

n. Set the TOL IN/TOL OUT switch to TOL IN.

o. Advance the CAPACITANCE control to the adjusted nominal pF value that was derived in step j. (For the step j example, the MULTIPLY C switch would be in the .1 position and the CAPACITANCE control would be advanced to 600 on the upper dial and to 34.8 on the lower dial.)

p. The 77B-S1 now is programmed to perform its dual-limit testing functions. The green lamp indicates that the value of a test specimen is within tolerance, the yellow lamp

indicates that the inductance of the specimen exceeds the programmed upper limit, and the red lamp indicates that the inductance of the specimen is less than the programmed lower limit.

3-26 SINGLE-LIMIT INDUCTANCE TEST FOR 77B-S1

Only one limit is programmed into the 77B-S1 in this procedure. Inductance specimens are tested in terms of equivalent capacitance, and a panel-lamp readout indicates whether or not each specimen is within tolerance. (Note that the out-of-tolerance lamp indications for inductance tests are the reverse of those obtained during capacitance tests.)

a. Check that the preliminary adjustments on the front panel are in accordance with Table 3-2.

b. Connect the system test cables or the remote test jig, as applicable, to the STD HI/LO coaxial connectors on the front panel.

c. Determine the required limit value and set the MULTIPLY C, DIVIDE G/MULTIPLY R, and C/L switches to the positions indicated in the chart below. If the tolerance is in percentage, convert it to mH values and algebraically add the required tolerance to the nominal value of the specimen. (For example, a ±5% tolerance for a nominal 40 mH inductor is equivalent to ±2 mH, or 42 mH if the upper limit is required and 38 mH if the lower limit is required.)

Limit Value	MULTIPLY C Switch	DIVIDE G/ MULTIPLY R Switch	C/L Switch
2.5 mH to 25 mH	1	1	L
25 mH to 250 mH	.1	10	L

d. If the MULTIPLY C switch is in the 1 position, set the TOL MULT switch to 20 and the DIVIDE G/MULTIPLY R switch to 1.

e. Zero balance the bridge in accordance with the procedure in Paragraph 3-5b.

f. Set the CONDUCTANCE control to the -100 position (tenth subdivision on G scale to the left of zero).

g. Adjust the PHASE ADJ control for a lamp threshold-crossover indication.

h. Return the CONDUCTANCE control to zero on the G scale.

i. Zero balance the bridge (Para. 3-5b).

j. Use the following equation to convert the inductance limit value to an equivalent pF value:

$$C = \frac{2533}{L}$$

Where

C = capacitance in pF

L = inductance in mH

(If the upper limit were required in the example given in step c, 42 mH would convert to 60.3 pF. If the lower limit were required, 38 mH would convert to 66.6 pF.)

k. Advance the CAPACITANCE control to the pF value derived in step j, above. (For the upper limit in the example above, the MULTIPLY C switch would be in the .1 position, and the CAPACITANCE control would be advanced to 600 on the upper dial and to 3 on the lower dial. If the lower limit were required, the CAPACITANCE control would be advanced to 600 on the upper dial and to 66 on the lower dial.)

l. The 77B-S1 now is programmed to perform its single-limit testing functions. The yellow lamp indicates that a test specimen is higher in inductance than the programmed limit, and the red lamp indicates that the specimen is lower in inductance than the programmed limit. Thus, if the lower limit is being used, a glowing yellow lamp indicates that the specimen is within tolerance, and a glowing red lamp warns that the inductance of the specimen is less than the programmed limit. If the upper limit is being used, a glowing red lamp indicates that the specimen is within tolerance, and a glowing yellow lamp warns that the inductance of the specimen exceeds the programmed limit.

3-27 OPTIMIZING TOLERANCE ACCURACY

The 1% accuracy of the tolerance circuit can be increased to 0.1% which is the basic accuracy of the 77B-S1 (Para. 1-5a and b). For optimum tolerance accuracy during dual-limit testing, perform the following procedure after the required pF tolerance value has been programmed into the TOL ±pF control in Paragraphs 3-23k or 3-25m.

a. Set the CAPACITANCE control upscale to the tolerance value derived in Paragraph 3-23h or 3-25j, as applicable.

b. Release the dial latch on the TOL ±pF control and slowly turn the control back and forth until the panel lamp glow just transfers from yellow to green.

c. Lock the TOL ±pF control by holding the dial steady and pushing the dial latch to the down position.

d. Perform the remainder of the dual-limit test procedure.

CHAPTER 4

PERFORMANCE TESTS

4-1 USING THE EQUIPMENT PERFORMANCE CHECKLIST

Use the equipment performance checklist in Table 4-1 to test the functional operation of the capacitance bridge. The checklist procedure applies to both the 77B and the 77B-S1 unless otherwise indicated. When using the checklist, perform every step of the procedure in the numerical sequence indicated. A properly functioning capacitance bridge must meet the performance standard in every step of the checklist. If the performance of the capacitance bridge is substandard, contact either the Boonton Electronics Corporation or your nearest sales representative for consultation or shipping instructions. Typical applications of the equipment performance checklist are as follows:

a. When the capacitance bridge is first unpacked (Para. 2-1b), as a check for any malfunctions caused by shipment.

b. Whenever substandard performance of the capacitance bridge is suspected.

c. Semiannually, as a periodic performance test.

4-2 TEST EQUIPMENT AND ACCESSORIES REQUIRED

a. One Multimeter, Simpson Model 260; or VTVM, RCA Voltohmyst Model WV-77E, or equivalent.

b. One RF Voltmeter, Boonton Electronics Type 91, or equivalent.

c. One 10 KΩ, 1/2 watt resistor.

d. One 2-conductor, 1/4" telephone plug equipped with two leads (tip and sleeve) approximately one-foot long.

Table 4-1. Equipment Performance Checklist

Step	Item	Action or Condition	Performance Standard
1.	Initial adjustments.	a. Power cable is connected to a compatible ac source and power switch is in off position.	a. Panel lamps are extinquished and NULL INDICATOR pointer rests at zero.
		b. Operate power switch to ON and allow one hour for warm-up.	b. Panel lamps glow at random and NULL INDICATOR pointer deflects upscale.
		c. Adjust front-panel controls in accordance with Table 3-2.	c. None.
2.	Bridge circuit alignment and synchronism with metering circuits.	a. Turn CAPACITANCE control fully clockwise.	a. CAPACITANCE control turns one full revolution and stops at -50 pF. Red panel lamp glows.
		b. Slowly advance CAPACITANCE control to +50 pF.	b. Panel lamps indicate crossover from red to yellow. NULL INDICATOR pointer dips toward zero in synchronism with lamp crossover and then deflects upscale as CAPACITANCE dial approaches 50 pF.
		c. Turn CAPACITANCE control back to zero.	c. None.
3.	Zero balance.	a. Check that all front-panel controls are in accordance with Table 3-2.	a. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	Zero balance (Cont.)	b. Zero balance the bridge (Para. 3-5b).	b. NULL INDICATOR pointer dips to within one increment of zero on meter scale and panel lamps give a crossover indication. R/G ZERO control is at 12 o'clock ±1 hour.
		c. Set the MULTIPLY C switch to .1. Set the DIVIDE G/MULTIPLY R switch to 100. Zero balance the bridge (Para. 3-5b).	c. Same as step b, above.
		d. Set the DIVIDE G/ MULTIPLY R switch to 10 and zero balance the bridge (Para. 3-5b).	d. Same as step b, above.
		e. Set the DIVIDE G/ MULTIPLY R switch to 1 and zero balance the bridge (Para. 3-5b). (Note that the CONDUCTANCE control is adjusted for a meter null during zero balance.)	e. Same as step b, above, except the R/G ZERO control need not be within 1 hour of 12 o'clock.
4.	Oscillator circuit.	a. Check that all front-panel controls are in accordance with Table 3-2.	a. None.
		b. Remove terminal shield from TEST binding posts.	b. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	Oscillator circuit (Cont.)	c. Set up rf voltmeter to measure approximately 1 millivolt.	c. None.
		d. Rotate TEST LEVEL control fully counterclockwise.	d. None.
		e. Connect rf voltmeter probe tip to TEST LO binding post. Connect probe clip to TEST ground binding post.	e. Rf voltmeter indicates less than 1 mV.
		f. Adjust rf voltmeter to measure approximately 300 millivolts and then rotate TEST LEVEL control fully clockwise.	f. Rf voltmeter indicates at least 250 mV.
		g. Remove test probe from capacitance bridge.	g. None.
		h. Install terminal shield on TEST binding posts.	h. None.
5	A. Model 77B phase discriminator circuit.	a. Set MULTIPLY C switch to .01.	a. None.
		b. Set DIVIDE G/MULTIPLY R switch to 10.	b. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	A. Model 77B phase discriminator circuit (Cont.)	c. Set C/L switch to L.	c. None.
		d. Adjust C ZERO COARSE and FINE controls and R/G ZERO control until bridge is zero balanced.	d. NULL INDICATOR pointer dips to within one increment of zero and panel lamps give a crossover indication.
		e. Simulate a 10 pF Q of 7 by advancing CONDUCTANCE control to 100 μmhos on G scale.	e. NULL INDICATOR pointer moves upscale.
		f. Carefully adjust PHASE ADJ control until panel lamps just crossover.	f. Panel-lamp crossover occurs within ±2 hours of 12 o'clock.
		g. Simulate a 10 pF Q of 10 by turning CONDUCTANCE control to 70 μmhos on G scale.	g. None.
		h. Slowly advance CAPACITANCE control until panel lamps just crossover.	h. Panel lamp crossover occurs within ±3 pF on lower scale of CAPACITANCE dial.
		i. Turn CAPACITANCE control back to zero.	i. None.
		j. Simulate a 10 pF Q of 2 by advancing CONDUCTANCE control to 330 μmhos on G scale.	j. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	A. Model 77B phase discriminator circuit (Cont.)	k. Carefully turn CAPACITANCE control in either direction until panel lamps just crossover.	k. Panel lamps crossover within ±15 pF on lower scale of CAPACITANCE dial.
		l. Turn CAPACITANCE control back to zero.	l. None.
		m. Simulate a 10 pF Q of 1 by advancing CONDUCTANCE control to 700 μmhos on G scale.	m. None.
		n. Carefully turn CAPACITANCE control in either direction until panel lamps just crossover.	n. Panel lamps crossover within ±30 pF on lower scale of CAPACITANCE dial.
	B. Model 77B-S1 phase discriminator circuit.	Repeat 77B procedure, above, except in step b set the DIVIDE G/ MULTIPLY R switch to 100.	Same as steps a thru n, above.
6	A. Model 77B sensitivity.	a. Check that all front-panel controls are in accordance with Table 3-2.	a. None.
		b. Set MULTIPLY C switch to .0001.	b. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	A. Model 77B sensitivity (Cont.)	c. Zero balance the bridge (Para. 3-5b).	c. NULL INDICATOR pointer dips to within one increment of zero on meter scale and panel lamps give a crossover indication.
		d. Carefully adjust CAPACITANCE control for a panel-lamp crossover indication. Read CAPACITANCE dial.	d. CAPACITANCE dial reads <2 pF.
	B. Model 77B-S1 sensitivity.	a. Check that all front-panel controls are in accordance with Table 3-2.	a. None.
		b. Set MULTIPLY C switch to .001.	b. None.
		c. Zero balance the bridge (Para. 3-5b).	c. NULL INDICATOR pointer dips to within one increment of zero on meter scale and panel lamps give a crossover indication.
		d. Carefully adjust CAPACITANCE control for a panel-lamp crossover indication. Read CAPACITANCE dial.	d. CAPACITANCE dial reads <0.5 pF.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
7.	Internal bias voltage.	a. Check that all front-panel controls are in accordance with Table 3-2.	a. None.
		b. Remove terminal shield from TEST binding posts.	b. None.
		c. Turn the DC BIAS switch to +INT.	c. None.
		d. Set up multimeter to measure at least +150 volts.	d. None.
		e. Connect multimeter positive prod to TEST HI binding post and negative prod to TEST LO binding post.	e. Multimeter indicates zero on the dc scale.
		f. Rotate DC BIAS INTERNAL ADJUST control clockwise as far as it will go.	f. Multimeter pointer deflects smoothly from zero to +140, ±10, volts on dc scale.
		g. Rotate DC BIAS INTERNAL ADJUST control counterclockwise as far as it will go.	g. Multimeter pointer dips smoothly back to zero.
		h. Set up multimeter to measure at least -10 volts.	h. None.
		i. Turn DC BIAS switch to -INT.	i. Multimeter indicates zero on dc scale.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	Internal bias voltage, (Cont.)	j. Rotate DC BIAS INTERNAL ADJUST control clockwise as far as it will go.	j. Multimeter pointer deflects smoothly from zero to -6, ±0.5, volts on dc scale.
		k. Rotate DC BIAS INTERNAL ADJUST control counterclockwise as far as it will go.	k. Multimeter pointer dips smoothly back to zero.
		l. Remove multimeter prods from TEST binding posts and connect them to DC BIAS INTERNAL MONITOR VOLTAGE binding posts (positive prod on upper post and negative prod on ground post).	l. Multimeter pointer indicates zero on dc scale.
		m. Rotate DC BIAS INTERNAL ADJUST control clockwise as far as it will go.	m. Multimeter pointer deflects smoothly from zero to -6, ±0.5, volts on the dc scale.
		n. Rotate DC BIAS INTERNAL ADJUST control counterclockwise as far as it will go.	n. Multimeter pointer dips smoothly back to zero.
		o. Turn DC BIAS switch to +INT.	o. Multimeter pointer indicates zero.
		p. Set up multimeter to measure at least 150 volts dc.	p. Multimeter pointer indicates zero

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	Internal bias voltage. (Cont.)	q. Rotate DC BIAS INTERNAL ADJUST control clockwise as far as it will go.	q. Multimeter pointer deflects smoothly from zero to 140, ±10, volts on dc scale.
		r. Rotate DC BIAS INTERNAL ADJUST control counterclockwise as far as it will go.	r. Multimeter pointer dips smoothly back to zero.
		s. Turn DC BIAS switch to OFF and remove test prods.	s. None.
8.	Internal bias current.	a. Check that DC BIAS INTERNAL ADJUST control is fully counterclockwise.	a. None.
		b. Set DC BIAS switch to +INT.	b. None.
		c. Connect a 10K ohm 1/2 watt resistor across TEST HI and LO binding posts.	c. None.
		d. Set up multimeter to measure at least 5 mA dc.	d. None.
		e. Connect multimeter positive prod to tip lead (center conductor) on telephone plug and the negative prod to	e. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	Internal bias current. (Cont.)	sleeve lead (outer conductor) on telephone plug.	
		f. Insert telephone plug into DC BIAS INTERNAL MONITOR CURRENT jack.	f. Multimeter indicates zero on dc scale.
		g. Rotate DC BIAS INTERNAL ADJUST control clockwise as far as it will go.	g. Multimeter pointer deflects smoothly from zero to 4.4 mA, ±10%.
		h. Rotate DC BIAS INTERNAL ADJUST control counterclockwise as far as it will go.	h. Multimeter pointer dips smoothly back to zero.
		i. Remove 10K ohm resistor from TEST HI and LO binding posts.	i. None.
		j. Remove multimeter prods from telephone plug leads.	j. None.
		k. Remove telephone plug assembly from DC BIAS INTERNAL MONITOR CURRENT jack.	k. None.
9.	External bias continuity.	a. Set DC BIAS switch to EXT.	a. None.
		b. Set up multimeter to measure resistance on lowest R setting.	b. None.

Table 4-1. Equipment Performance Checklist (Cont.)

Step	Item	Action or Condition	Performance Standard
	External bias continuity. (Cont.)	c. Connect one multimeter prod to DC BIAS EXTERNAL binding post that is ungrounded and the other prod to TEST HI binding post.	c. Multimeter indicates 20, ±6, ohms.
		d. Remove multimeter prods from binding posts.	d. None.
		e. Set DC BIAS switch to OFF.	e. None.

TABLE OF REPLACEABLE PARTS

FOR 77B

Note: Component parts in the bridge assembly are not listed because their replacement usually must be followed by adjustments that require specialized equipment and techniques.

-CAPACITORS-

Reference		Description			BEC Part No.
C101	Durmica	150pF	±5% 500V	ARCO DM-15-151J	200,032
C102	Mylar	0.002μF	±5% 200V	Sprague 192P20252	234,024
C103	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C104	Durmica	120pF	±5% 500V	ARCO DM-15F-121J	200,002
C105	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C106	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C107	Ceramic	36pF	±5% N750ppm/°c	Erie 301-651-U2	220,117
C108	Var. Air	1 to15pF		Jackson Bros. Type C808	275,123
C109	Durmica	120pF	±5% 500V	ARCO DM-15F-121J	200,002
C110	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C111	Durmica	120pF	±5% 500V	ARCO DM-15F-121J	200,002
C112	Paper	0.5μF	200V	Aerovox P8292ZN12	230,135
C113	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C114	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C115	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C116	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C117	Durmica	10pF	±5% 500V	ARCO DM-10C-100J	200,022
C118	Durmica	330pF	±1% 500V	ARCO DM-15-331F	200,033
C119	Durmica	330pF	±1% 500V	ARCO DM-15-331F	200,033
C120	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C121	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C123	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C124	Mylar	0.047μF	±10% 400V	Sprague 192P47394	234,047
C125	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C126	Mylar	0.01μF	±20% 200V	Sprague 192P10392	234,027
C127	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C128	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C129	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C130	Durmica	300pF	±5% 500V	ARCO DM-15-301J	200,034
C131	Mylar	0.002μF	±5% 200V	Sprague 192P2252	234,024
C132	Mylar	0.002μF	±5% 200V	Sprague 192P2252	234,024
C133	Electrolytic	50μF	25V	Sprague TE-1209	283,159
C134	Electrolytic	50μF	25V	Sprague TE-1209	283,159
C135	Mylar	0.1μF	±20% 200V	Sprague 192P10492	230,116
C136	Durmica	470pF	±5% 500V	ARCO DM-15-471J	200,028
C201	Mylar	0.01μF	±20% 400V	Sprague 192P10394	234,021

Reference	Description				BEC Part No.
C202 Durmica	150pF	±5%	500V	ARCO DM-15-151J	200,032
C203 Durmica	68pF	±5%	500V	ARCO DM-15-680lJ	200,031
C204 Mylar	0.1µF	±10%	200V	Sprague 192P10492	230,116
C205 Var. Air	50pF			Hammarlund MAPC-50	275,103
C206 Durmica	330pF	±1%	500V	ARCO DM-15-331F	200,033
C207 Mylar	0.01µF	±10%	200V	Sprague 192P10392	234,027
C208 Durmica	68pF	±5%	500V	ARCO DM-15-680J	200,031
C209 Mylar	0.1µF	±10%	200V	Sprague 192P10492	230,116
C210 Mylar	0.1µF	±10%	200V	Sprague 192P10492	230,116
C211 Mylar	0.01µF	±10%	200V	Sprague 192P10392	234,027
C212 Mylar	0.01µF	±10%	200V	Sprague 192P10392	234,027
C213 Paper	1.0µF	±20%	100V	Electron WI-105	236,007
C214 Mylar	0.1µF	±10%	200V	Sprague 192P10492	230,116
C301a Electrolytic	20-20µF		450V	Mallory FP-234	283,100
C301b Electrolytics	20-20µF		450V	Mallory FP-234	283,100
C401 Var. Air	3.2-50pF			Hammarlund MAPC-50	275,103
C404 Var. Air	500pF	±1%	500V	BEC	077,112
C405 Var. Piston	0.7-30pF			Johanson 1902	279,103
C406 Var. Piston	0.7-30pF			Johanson 1902	279,103
C407 Var. Piston	0.01-1.5 pF			Johanson 4484	279,111
C408 Var. Piston	0.4-8pF			Johanson 1802	279,101
C409 Mica, Sil	100pF	±1%	500V	Arco CM20F101F	201,124
C410 Var. Piston	0.4-8pF			Johanson 1802	279,101
C411 Paper	0.022µF	±10%	200V	Sprague 19222392	230,101
C412 Var. Air	500pF	±.1%	500V	BEC	077,112
C413 Plastic Film	0.15µF	±10%	100V	Corn. Dublier WMF1P15	234,038
C414 Ceramic	4.5-25pF			Erie NPO TS2A	281,000
C415 Var. Piston	0.7-3pF			Erie 535-007	279,109
C416 Met. Paper	1.0µF	±20%	400V	Aerovox P8292ZN22	235,021
C417 Var. Air	10-10pF			Jackson Bros. C808	275,12
C418 Var. Air	0.1pF			Jackson Bros. C808	275,123

-RESISTORS-

R101 Comp.	220K	±5%	1/2Watt	AB Type EB	301,143
R102 Comp.	470Ω	±5%	1/2Watt	AB Type EB	301,079
R103 Comp.	2.2K	±5%	1/2Watt	AB Type EB	301,095
R104 Comp.	100Ω	±5%	1/2Watt	AB Type EB	301,063
R105 Comp.	22K	±5%	1/2Watt	AB Type EB	301,119
R106 Comp.	220K	±5%	1/2Watt	AB Type EB	301,143
R107 Comp.	470Ω	±5%	1/2Watt	AB Type EB	301,079
R108 Comp.	220K	±5%	1/2Watt	AB Type EB	301,143
R109 Comp.	100Ω	±5%	1/2Watt	AB Type EB	301,063
R110 Comp.	2.2K	±5%	1/2Watt	AB Type EB	301,095
R111 Comp.	220K	±5%	1/2Watt	AB Type EB	301.043
R112 Comp.	22K	±5%	1/2Watt	AB Type EB	301,119
R113 Comp.	2.2K	±5%	1/2Watt	AB Type EB	301,095
R114 Comp.	470Ω	±5%	1/2Watt	AB Type EB	301,079
R115 Comp.	100Ω	±5%	1/2Watt	AB Type EB	301,063
R116 Comp.	1 M	±5%	1/2Watt	AB Type EB	301,159
R117 Comp.	1 M	±5%	1/2Watt	AB Type EB	301,159

Reference		Description			BEC Part No.
R118	Comp.	7.5K	±5% 1/2Watt	AB Type EB	301,108
R119	Comp.	510K	±5% 1/2Watt	AB Type EB	301,152
R120	Comp.	510K	±5% 1/2Watt	AB Type EB	301,152
R121	Comp.	10 K	±5% 1/2Watt	AB Type EB	301,111
R122	Comp.	10 K	±5% 1/2Watt	AB Type EB	301,111
R123	Comp.	10 Ω	±5% 1/2Watt	AB Type EB	301,039
R124	Comp.	680K	±5% 1/2Watt	AB Type EB	301,155
R125	Comp.	1 K	±5% 1/2Watt	AB Type EB	301,087
R126	Comp.	2.2M	±5% 1/2Watt	AB Type EB	301,167
R128	Var. Trimpot	2 K	±10% 1/2Watt	Bourns 200L-1-202M	311,217
R129	Comp.	510K	±5% 1/2Watt	AB Type EB	301,152
R130	Comp.	510K	±5% 1/2Watt	AB Type EB	301,152
R131	Comp.	22 K	±5% 1/2Watt	AB Type EB	301,152
R132	Comp.	51K	±5% 1/2Watt	AB Type EB	301,128
R133	Comp.	10K	±5% 1/2Watt	AB Type EB	301,111
R134	Comp.	1.5K	±5% 1/2Watt	AB Type EB	301,091
R201	Dep. Car.	17.8K	±1% 1/2Watt	Dale Type DCS 1/2	306,388
R202	Dep. Car.	1 K	±1% 1/2Watt	Dale Type DCS 1/2	306,239
R203	Dep. Car.	100Ω	±1% 1/2Watt	Dale Type DCS 1/2	306,120
R204	Dep. Car.	10Ω	±1% 1/2Watt	Dale Type DCS 1/2	306,000
R205	Comp.	51K	±5% 1/2Watt	AB Type EB	301,128
R206	Comp.	2.2K	±5% 1/2Watt	AB Type EB	301,095
R207	Comp.	2.2K	±5% 1/2Watt	AB Type EB	301,095
R208	Var.	50K	±5% 10 Turn WW	Clarostat 62-JA-50K	311,196
R209	Dep. Car.	100K	±1% 1/2Watt	Dale Type DCS 1/2	306,478
R210	Comp.	100K	±5% 1/2Watt	AB Type EB	301,135
R211	Comp.	2,2K	±5% 1/2Watt	AB Type EB	301,095
R212	Comp.	300K	±5% 1/2Watt	AB Type EB	301,146
R213	Var. Trimpot	200K	0.2Watt	Bourns 274-1-204M	311,216
R214	Dep. Car.	16.5K	±1% 3/8Watt	Texas Instrument MC60D	326,381
R301	Comp.	1 M	±20% 1 Watt	AB Type GB	301,128
R302	Wirewound	1.5K	±5% 8 Watt	Ohmite No. 1536	310,315
R401	Dep. Car.	675Ω	±1% 1/2Watt	Texas Instrument CD 1/2PR	306,695
R402	Var. Trimpot	2 K	±10% 1/4 Watt	Bourns 200L-1-202	311,203
R404	Dep. Car.	49.9K	±1% 1/4Watt	Mepco C10	305,442
R405	Dep. Car.	301Ω	±1% 1/4Watt	Mepco C10	305,177
R406	Dep. Car.	4.75K	±1% 1/4Watt	Mepco C10	305,321
R407	Dep. Car.	499K	±1% 1/4Watt	Mepco C10	305,562
R408	Dep. Car.	200Ω	±1% 1/4Watt	Mepco	305,156
R409	Var.	250Ω	±10% 2 Watt	AB J87652	311,161
R410	Dep. Car.	422Ω	±1% 1/4Watt	Mepco	305,156
R412	Var.	10K	±10% 2 Watt	AB JA2N048S103UE	311,124
R501	Var.	50K	±5% 10 Turn WW	Clarostat 62-JA-50K	311,198
R502	Comp.	24K	±5% 2 Watt	AB Type HB	304,120
CR101	Diode	1N58AS	Germanium	Sylvania	530,021
CR102	Diode	1N251	Silicon	Texas Instrument	530,043
CR103	Diode	1N58AS	Germanium	Sylvania	530,021

Reference		Description			BEC Part No.
CR104	Diode	1N58AS	Germanium	Sylvania	530,021
CR105	Diode	1N914	Silicon	Texas Instrument	530,058
CR106	Diode	1N914	Silicon	Texas Instrument	530,058
CR107	Diode	1N914	Silicon	Texas Instrument	530,058
CR108	Diode	1N251	Silicon	Texas Instrument	530,043
CR109	Diode	1N2069	Silicon	Texas Instrument	530,053
CR110	Diode	1N2069	Silicon	Texas Instrument	530,053
CR111	Diode	1N2069	Silicon	Texas Instrument	530,053
CR112	Diode	1N2069	Silicon	Texas Instrument	530,053
CR113	Diode	UZ806	Zener	Unitrode	530,041
CR201	Diode	1N251	Silicon	Texas Instrument	530,043
CR202	Diode	1N251	Silicon	Texas Instrument	530,043
CR301	Diode	UZ806	Zener	Unitrode	530,041
DS101	Light	Limit	Green	Dialco No. 101-5030-972	474,110
DS102	Light	Limit	Red	Dialco No. 101-5030-971	474,109
DS103	Light	Limit	Yellow	Dialco No. 101-5030-976	474,112
F301	Fuse	1.2A at 125V (Slo-blo)		Buss MDL 1-2/10	545,509
K101	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
K102	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
K103	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
K104	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
L101	Coil, Var., RF	100-175μH		North Hills 1500A	400,115
L102	Choke, RF	1000μH	±5%	Essex RFC-L	400,095
L103	Coil, Var., RF	100-175μH		North Hills 1500A	400,115
L104	Choke, RF	1000μH	±5%	Essex RFC-L	400,095
L105	Coil, Var., RF	100-175μH		North Hills 1500A	400,115
L106	Choke, RF	1000μH	±5%	Essex RFC-L	400,095
L107	Coil, Var., RF	100-175μH		North Hills 1500A	400,115
L108	Choke, RF	1500μH		Stanwyck Dinkductor	400,136
L201	Choke, RF	1000μH	±5%	Essex RFC-L	400,095
L202	Coil, Var.,RF	100-175μH		North Hills 1500A	400,115
L301	Choke, Power	7H 500Ω 50 ma		Stancor C 1707	440,001
L403	Choke, RF	1000μH	±5%	Nytronics RFC-L	400,095
M101	Meter, Taut Band 50μa Scale			Weston No. 1921-7	554,140
S201	Switch, Rotary	2P-4T		Oak Type A	466,156
S202	Switch, Slide	DPDT		Oak Type 78	465,112
S301	Switch, Toggle	SPST		Carling No. 110-63	465,105
S401	Switch, Rotary	2P-5POS		Centralab PA 279-1514	466,120
S402	Switch, Rotary	2P-4POS		Centralab PA279- 1194	466,108
S403	Switch, Rotary	4P-2T		Centralab PA-279-1765	466,126
S501	Switch, Rotary	2P-4P		Oak Type J	466,171
T301	Transformer, Power			Stancor No. 1377	446,007

Reference		Description		BEC Part No.
T302	Transformer, 6.3V	At 2.38	Sola Type CV-5	446,024
T401	Transformer, Bridge Assy		BEC	075,212
V101	Tube, 6AU6			526,6AU6
V102	Tube, 6AU6			526,6AU6
V103	Tube, 6AU6			526,6AU6
V104	Tube, 6AU6			526,6AU6
V105	Tube, 12AT7			526,12AT7
V106	Tube, 12AT7			526,12AT7
V201	Tube, 6AU6			526,6AU6
V301	Tube, 6X4			526,6X4
V302	Tube, OA2			526,OA2
Y101	Osc. Crystal	1 Mc	James Knight CR 18/U	547,015

TABLE OF REPLACEABLE PARTS

FOR 77B-S1

Note: Component parts in the bridge assembly are not listed because their replacement usually must be followed by adjustments that require specialized equipment and techniques.

- CAPACITORS -

Reference		Description				BEC Part No.
C101	Durmica	470 pF	±5%	300 V	ARCO DM-15-471-J	200,028
C102	Durmica	240 pF	±5%	500 V	ARCO DM-15-241-J	200,506
C103	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C104	Mylar	0.002 µF	±5%	200 V	Sprague 192P 20252	234,024
C105	Met. Paper	1.0 µF	±20%	100 V	Electron W1-105	236,007
C106	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C107	Ceramic	36 pF	±5%	N750 ppm/°c	Erie 301-651-U2-J-360-J	220,117
C108	Var. Air	25 pF			Jackson Bros. Type C808	275,140
C109	Durmica	330 pF	±1%	500 V	ARCO DM-15-331-F	200,033
C110	Met. Paper	1.0 µF	±20%	100 V	Electron W1-105	236,007
C111	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C112	Paper	0.5 µF		200 V	Aerovox P8292ZN12	230,135
C113	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C114	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C115	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C116	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C117	Durmica	56 pF	±5%	500 V	ARCO DM-15-560-J	200,030
C118	Durmica	1000 pF	±1%	500 V	ARCO DM-19-102-F	200,509
C119	Durmica	1000 pF	±1%	500 V	ARCO DM-19-102-F	200,509
C120	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C121	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C123	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C124	Mylar	0.047 µF	±10%	400 V	Sprague 192P 47394	234,047
C125	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C126	Mylar	0.068 µF	±5%	200 V	Sprague 192P 68352	234,051
C127	Mylar	0.01 µF	±10%	200 V	Sprague 192P 10392	234,027
C128	Durmica	3000 pF	±5%	500 V	ARCO DM-19-302-J	200,510
C129	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C130	Mylar	0.002 µF	±5%	200 V	Sprague 192P 20252	234,024
C131	Mylar	0.002 µF	±5%	200 V	Sprague 192P 20252	234,024
C132	Mylar	0.002 µF	±5%	200 V	Sprague 192P 20252	234,024
C133	Electrolytic	50 µF		25 V	Sprague TE-1209	283,159
C134	Electrolytic	50 µF		25 V	Sprague TE-1209	283,159
C135	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C136	Durmica	470 pF	±5%	300 V	ARCO DM-15-471-J	200,028
C137	Ceramic	36 pF	±5%	N750 ppm/°c	Erie 301-651-U2-J-360-J	220,117

Reference		Description				BEC Part No.
C138	Mylar	0.01 µF	±20%	400 V	Sprague 192P 10394	234,021
C201	Mylar	0.01 µF	±20%	400 V	Sprague 192P 10394	234,021
C202	Durmica	470 pF	±5%	300 V	ARCO DM-15-471-J	200,028
C203	Durmica	68 pF	±5%	500 V	ARCO DM-15-680-J	200,031
C204	Met. Paper	1.0 µF	±20%	100 V	Electron W1-105	236,007
C205	Var. Air	50 pF			Hammarlund MAPC-50	275,103
C206	Durmica	3000 pF	±5%	500 V	ARCO DM-19-302-J	250,510
C207	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C208	Durmica	300 pF	±5%	500 V	ARCO DM-15-301-J	200,034
C209	Met. Paper	1.0 µF	±20%	100 V	Electron W1-105	236,007
C210	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C211	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C212	Mylar	0.1 µF	±10%	200 V	Sprague 192P 10492	230,116
C213	Met. Paper	1.0 µF	±20%	100 V	Electron W1-105	236,007
C214	Paper	1.0 µF	±20%	200 V	Aerovox P8292ZN13D	230,104
C215	Durmica	180 pF	±5%	500 V	ARCO DM-15-F-181-J	200,055
C301	Electrolytic	20-20 µF		450 V	Mallory FP-234	283,100
C301a	Electrolytic	20-20 µF		450 V	Mallory FP-234	283,100
C301b	Electrolytic	20-20 µF		450 V	Mallory FP-234	283,100
C404	Var.Cap. Ass'y				BEC	077,159
C411	Plastic Film	0.33 µF	±10%	200 V	Cornell Dubilier WMF2P33	234,032
C412	Var.Cap. Ass'y				BEC	077,159
C413	Met. Mylar	0.22 µF	±20%	100 V	Electron DI-224	236,005
C414	Ceramic	25 pF			Erie 503-000-COPO-37R	281,000
C415	Var. Piston	3 pF			Erie 535-008-4R	279,109

- RESISTORS -

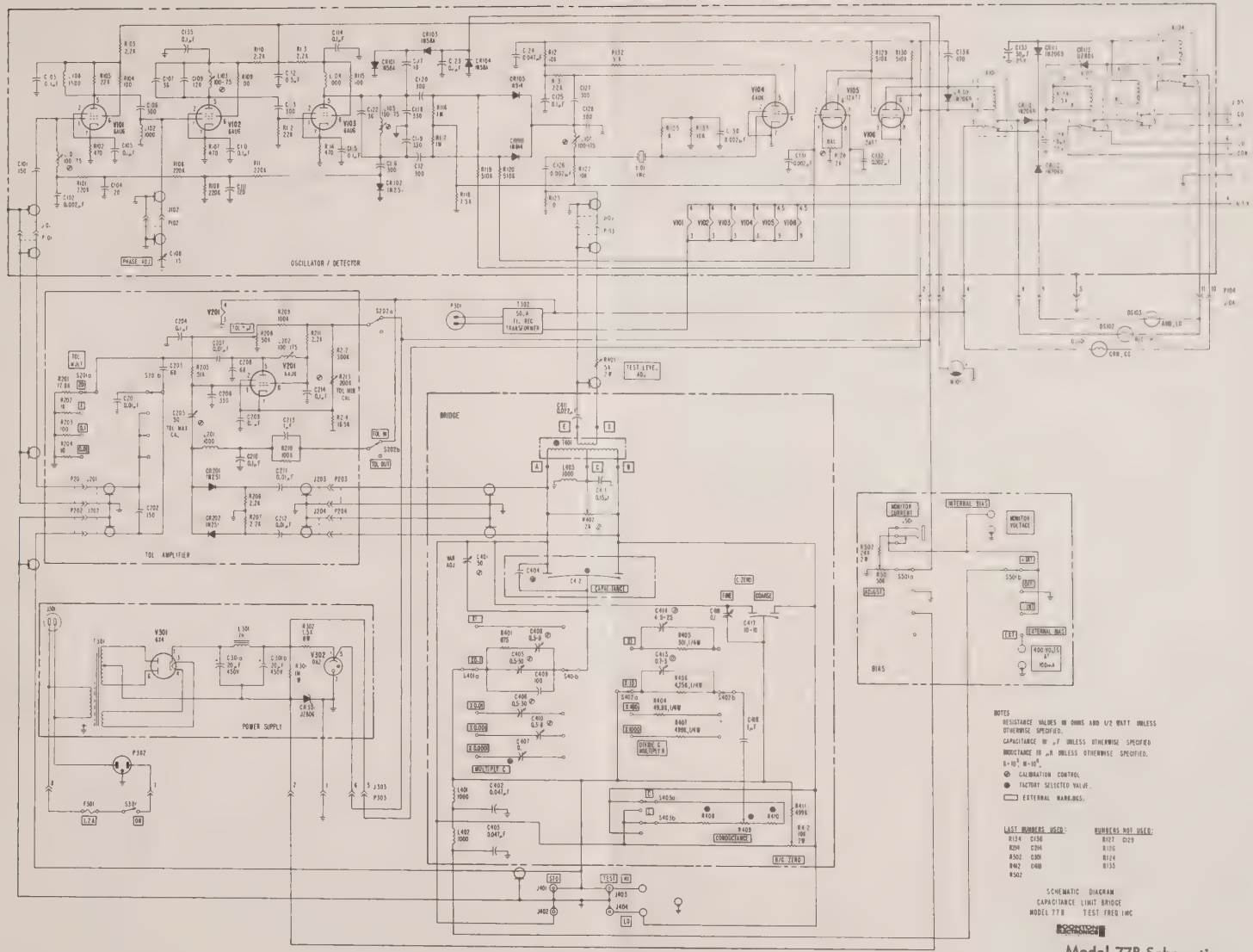
R101	Comp.	220 K	±5%	1/2 Watt	AB Type EB	301,143
R102	Comp.	470 Ω	±5%	1/2 Watt	AB Type EB	301,079
R103	Comp.	2.2 K	±5%	1/2 Watt	AB Type EB	301,095
R104	Comp.	100 Ω	±5%	1/2 Watt	AB Type EB	301,063
R105	Comp.	22 K	±5%	1/2 Watt	AB Type EB	301,119
R106	Comp.	220 K	±5%	1/2 Watt	AB Type EB	301,143
R107	Comp.	470 Ω	±5%	1/2 Watt	AB Type EB	301,079
R108	Comp.	220 K	±5%	1/2 Watt	AB Type EB	301,143
R109	Comp.	100 Ω	±5%	1/2 Watt	AB Type EB	301,063
R110	Comp.	2.2 K	±5%	1/2 Watt	AB Type EB	301,095
R111	Comp.	220 K	±5%	1/2 Watt	AB Type EB	301,143
R112	Comp.	22 K	±5%	1/2 Watt	AB Type EB	301,119
R113	Comp.	2.2 K	±5%	1/2 Watt	AB Type EB	301,095
R114	Comp.	470 Ω	±5%	1/2 Watt	AB Type EB	301,079
R115	Comp.	100 Ω	±5%	1/2 Watt	AB Type EB	301,063
R116	Comp.	1 M	±5%	1/2 Watt	AB Type EB	301,159
R117	Comp.	1 M	±5%	1/2 Watt	AB Type EB	301,159
R118	Comp.	7.5 K	±5%	1/2 Watt	AB Type EB	301,108
R119	Comp.	510 K	±5%	1/2 Watt	AB Type EB	301,152
R120	Comp.	510 K	±5%	1/2 Watt	AB Type EB	301,152
R121	Comp.	10 K	±5%	1 Watt	AB Type GB	302,125

Reference		Description				BEC Part No.
R122	Comp.	10 K	±5%	1/2 Watt	AB Type EB	301,111
R123	Comp.	10 Ω	±5%	1/2 Watt	AB Type EB	301,039
R124	Comp.	680 K	±5%	1/2 Watt	AB Type EB	301,155
R125	Comp.	22 K	±5%	1/2 Watt	AB Type EB	301,119
R126	Comp.	2.2 M	±5%	1/2 Watt	AB Type EB	301,167
R128	Var. Trimpot	2 K	±10%	1/2 Watt	Bourns 200L-1-202M	311,217
R129	Comp.	510 K	±5%	1/2 Watt	AB Type EB	301,152
R130	Comp.	510 K	±5%	1/2 Watt	AB Type EB	301,152
R132	Comp.	220 K	±5%	1/2 Watt	AB Type EB	301,143
R133	Comp.	1.5 K	±5%	1/2 Watt	AB Type EB	301,091
R201	Dep. Car.	20 K	±1%	1/2 Watt	Dale Type DCS 1/2	306,395
R202	Dep. Car.	1 K	±1%	1/2 Watt	Dale Type DCS 1/2	306,239
R203	Dep. Car.	100 Ω	±1%	1/2 Watt	Dale Type DCS 1/2	306,120
R204	Dep. Car.	10 Ω	±1%	1/2 Watt	Dale Type DCS 1/2	306,000
R205	Comp.	100 K	±5%	1/2 Watt	AB Type EB	301,135
R206	Comp.	2.2 K	±5%	1/2 Watt	AB Type EB	301,095
R207	Comp.	2.2 K	±5%	1/2 Watt	AB Type EB	301,095
R208	Var.	50 K	±5%	10 Turn WW	Clarostat 62-JA-50K	311,196
R209	Dep. Car.	100 K	±1%	1/2 Watt	Dale Type DCS 1/2	306,478
R210	Comp.	100 K	±5%	1/2 Watt	AB Type EB	301,135
R211	Comp.	2.2 K	±5%	1/2 Watt	AB Type EB	301,095
R212	Comp.	300 K	±5%	1/2 Watt	AB Type EB	301,146
R213	Var. Trimpot	200 K		0.2 Watt	Bourns 274-1-204M	311,216
R214	Dep. Car.	20 K	±1%	1/2 Watt	Texas Instruments MC60D	306,395
R215	Comp.	12 K	±5%	1/2 Watt	AB Type EB	301,113
R301	Comp.	1 M	±20%	1 Watt	AB Type GB	302,128
R302	Wirewound	1.5 K	±5%	8 Watt	Ohmite No. 1536	310,315
R404	Dep. Carb.	49.9 K	±1%	1/4 Watt	Mepco C10	305,442
R405	Dep. Carb.	301 Ω	±1%	1/4 Watt	Mepco C10	305,177
R406	Dep. Carb.	4.75 K	±1%	1/4 Watt	Mepco C10	305,321
R407	Dep. Carb.	449 K	±1%	1/4 Watt	Mepco C10	305,562
R411	Dep. Carb.	1.5 M	±1%	1/2 Watt		306,615
R501	Var.	50 K	±5%	10 Turn WW	Clarostat 62-JA-50K	311,198
R502	Comp.	24 K	±5%	2 Watt	AB Type HB	304,120

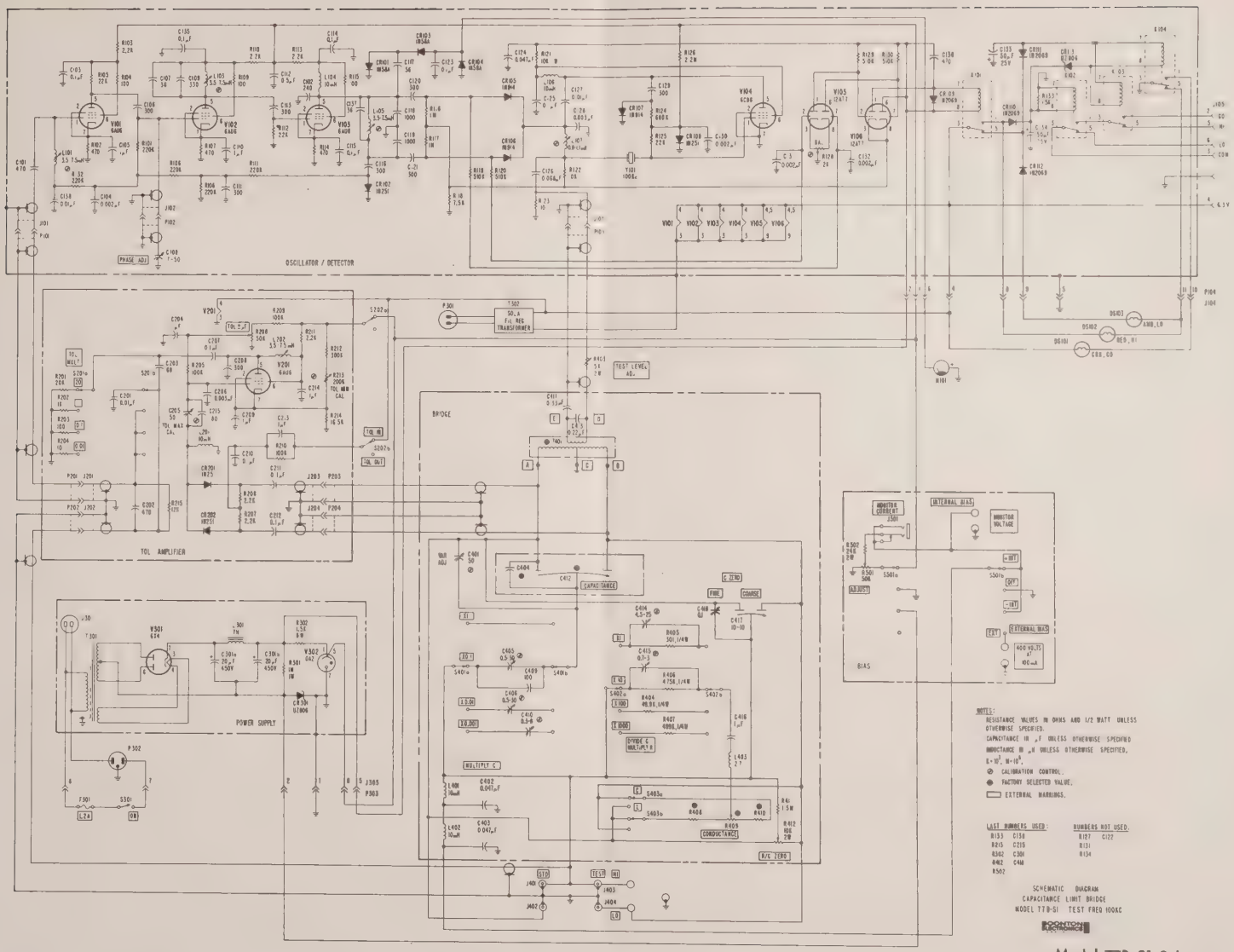
CR101	Diode	1N58A	Germanium	Sylvania 1N58AS	530,021
CR102	Diode	1N251	Silicon	Texas Instrument IN251	530,043
CR103	Diode	1N58A	Germanium	Sylvania 1N58AS	530,021
CR104	Diode	1N58A	Germanium	Sylvania 1N58AS	530,021
CR105	Diode	1N914	Silicon	Texas Instrument 1N914	530,058
CR106	Diode	1N914	Silicon	Texas Instrument 1N914	530,058
CR107	Diode	1N914	Silicon	Texas Instrument 1N914	530,058
CR108	Diode	1N251	Silicon	Texas Instrument 1N251	530,043
CR109	Diode	1N2069	Silicon	Texas Instrument 1N2069	530,053
CR110	Diode	1N2069	Silicon	Texas Instrument 1N2069	530,053
CR111	Diode	1N2069	Silicon	Texas Instrument 1N2069	530,053
CR112	Diode	1N2069	Silicon	Texas Instrument 1N2069	530,053
CR113	Diode	UZ806	Zener	Unitrode	530,041
CR201	Diode	1N251	Silicon	Texas Instrument	530,043
CR202	Diode	1N251	Silicon	Texas Instrument	530,043
CR301	Diode	UZ806	Zener	Unitrode	530,041

Reference		Description			BEC Part No.
DS101	Light	Limit	Green	Dialco No. 101-5030-972	474,110
DS102	Light	Limit	Red	Dialco No. 101-5030-971	474,109
DS103	Light	Limit	Yellow	Dialco No. 101-5030-976	474,112
F301	Fuse	1.2A at 125 V (Slo-Blo)		Buss MDL 1	545,509
K101	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
K102	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
K103	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
K104	Relay	Mercury Wetted Contacts		Adlake MWSL-16012-1B	471,005
L101	Coil, Adj.,RF	3.5-7.5 mH		North Hills No. 1500I	400,114
L103	Coil, Adj.,RF	3.5-7.5 mH		North Hills No. 1500I	400,114
L104	Choke, RF	10,000 µH	±5%	Essex Type RFC-L	400,101
L105	Coil, Adj.,RF	3.5-7.5 mH		North Hills No. 1500I	400,114
L106	Choke, RF	10,000 µH	±5%	Essex Type RFC-L	400,101
L107	Coil, Adj.,RF	0.8-1.1 mH		North Hills No. 1500 E	400,119
L201	Choke, RF	10,000 µH	±5%	Essex Type RFC-L	400,101
L202	Coil, Var.,RF	3.5-7.5 mH		North Hills No. 1500I	400,114
L301	Choke, Power	7 H 500 Ω	50 ma	Stancor C1707	440,001
L401	Choke, RF	10,000 µH	±5%	Nytronic RFC-L	400,101
L402	Choke, RF	10,000 µH	±5%	Nytronic RFC-L	400,101
L403	Choke, RF	27 µH	±10%	Nytronic 6501	400,121
M101	Meter, Taut Band	50 µA scale		Weston No. 1921T	554,140
S201	Switch,Rotary	2P-4T		Oak Type A	466,156
S202	Switch, Slide	DPDT		Oak Type 78	465,112
S301	Switch, Toggle	SPST		Carling No. 110-63	465,105
S401	Switch,Rotary	2P-4pos.		Centralab PA279-1766	466,129
S402	Switch,Rotary	2P-4pos.		Centralab PA279-1194	466,108
S501	Switch,Rotary	2P-4T		Oak Type J	466,171
T301	Transformer, Power			Stancor No. 1377	446,007
T302	Transformer, 6.3V	At 2.38 A		Sola Type CV-5	446,024
V101	Tube, 6AU6				526,6AU6
V102	Tube, 6AU6				526,6AU6
V103	Tube, 6AU6				526,6AU6
V104	Tube, 6CB6				526,6CB6
V105	Tube, 12AT7				526,12AT7
V106	Tube, 12AT7				526,12AT7
V201	Tube, 6AU6				526, 6AU6

Reference			Description	BEC Part No.
V301	Tube, 6X4			526,6X4
V302	Tube, OA2			526,OA2
Y101	Osc. Crystal	100 Kc	James Knight CR 37/U	547,016



Model 77B Schematic
Dwg. No. E830323N
(For Serial Nos. 458 & Above)



Model 77B-S1 Schematic
Dwg. No. E830331S
(For Serial Nos. 449 & Above)

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

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